INDIA ENERGY FORUM

22nd INDIA POWER FORUM

27th November 2019, Hotel Le Meridien, New Delhi

Power Sector Agenda Beyond 2020:
Challenges and Imperatives

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MESSAGE

D V KAPUR

Founder CMD NTPC & Ex. Secretary to GOI
Ministries of Power, Heavy Industry and Chemicals & Petrochemicals

Discovery of electricity in 1830s, development of commercial electricity production fifty years later and series of inventions of industrial applications and spread of this form of energy in twentieth century have been most remarkable technological stories of recent times.

Currently electricity industry is life-blood of economy. Its balanced growth and efficient management are, therefore, most important when faster economic growth, job creation and quality of everyday life of people are overriding priorities. Entities like India Energy Forum can and must play a vital catalystic role in that regard. “Power Sector Agenda Beyond 2020 – Challenges and Imperatives” is most appropriate theme for the Power Summit of 22nd India Power Forum.

I compliment India Energy Forum for its promotional role and wish the Summit great success.

D V Kapur

MESSAGE

Anil Razdan

President, India Energy Forum
Former Secretary, Ministry of Power,
Government of India

The India Power Forum is a land mark event of the India Energy Forum where leaders of India's power sector meet to analyse and discuss the most contemporaneous and significant issues facing the sector. This Forum is perhaps the oldest and most consistent annual professional event by a Think Tank which discusses issues relating to the power sector. It provides an opportunity for government functionaries, sector experts and industry to meet at a free and frank forum. This year the theme "Power Sector Agenda Beyond 2020: Challenges and Imperatives" has been chosen for the 22nd India Power Forum.

The Power Sector in India has attained tremendous progress over the last decade and a half. The country's power generation capacity has turned from a situation of massive deficit to a problem of plenty. Electricity has been taken to every home in India, the grid is entirely inter-connected, energy efficiency awareness pervades the sector, and the generation mix is undergoing a healthy change. However, the distribution sector, which is largely controlled by state governments, and is regulated by state electricity regulators, remains a major challenge.

Any economic activity presents constant new challenges and technologies will often provide new solutions. However, financial and operational discipline at the distribution end will need to be watched closely. Those who cannot perform or be accountable must perish.

The India Energy Forum earnestly hopes that the 22nd India Power Forum will live up to the expectations of the enthusiastic participants.

Anil Razdan

MESSAGE

H.L. BAJAJ

Former Chairperson, Central Electricity Authority & ex officio Secretary, Govt. of India
Ex Technical Member - Appellate Tribunal for Electricity,

This year our flagship event: 22nd INDIA POWER FORUM - of India Energy Forum being organized on November 27, 2019 will focus on the Challenges and Imperatives of Power Sector. Sustained faster economic growth of a nation requires reliable quality power at reasonable and affordable rates. Like the earlier years, 22nd India Power Forum brings together power sector professional experts engaged in policy formulation, practitioners, financiers, regulators and academicians. Challenges before the Sector remain; continuing losses of Distribution companies, Stressed Assets, Tariff determined by regulators not being cost reflective, non/delayed payment to renewables generators, reneging of PPAs, Integration of Renewables, Liquidation of Regulatory Assets created over the years disregarding the Policy framework thus creating cash flow problems. These experts will freely deliberate , discuss ,debate and closely interact among themselves to find solutions to increase power demand, rationalize tariffs which are very sensitive issues in our country made more complex as power is in the concurrent list of Schedule 7 the Constitution of India. Rationalized reasonable tariffs for power industry will make it competitive thereby increasing production, profits and result in accelerating India's GDP and, in turn, enhance utilization of power sector assets.

Looking forward welcoming you to the Power Forum on November 27, 2019 and interacting with you,

H.L.Bajaj
Chairman, Power Forum, IEF

MESSAGE

P S Bami
President Emeritus - IEF
Former CMD, NTPC Ltd.

India Energy Forum is organizing the 22nd Power Forum on 27th November, 2019 at Hotel Le Meridian, New Delhi and the Govt. of India has indentified the power sector as an important sector to play a major role in the industrial growth of the country.

It is also important to evaluate the role of UDAY launched by the Govt. of India and whether the identified objectives have been achieved and what other policy measures need to be taken to achieve the turnaround of DISCOMS. The economic growth of the country is linked to the availability of power for all the sectors of the economy.

In this backdrop the conference will debate and evaluate various measures which have been taken and also what needs to be done to achieve the objective of power for all.

I am confident that all the participants will be benefited from the deliberations.

I wish the conference a great success.

P.S. Bami

FOREWORD

The Power Sector reeling under huge stressed assets, welcomed the following measures approved by Cabinet to give relief:

Allowing use of domestic linkage of coal for short-term PPAs and procurement of bulk power by the model agency against pre-declared linkage. This is a positive step for thermal IPPs given that operational coal based capacity of 15-16 GW do not have long term PPAs. The use of domestic linkage coal will enable generators to offer more competitive tariff for short term role which is also likely to benefit DISCOMS, given that they are purchasing larger volumes through short term PPAs. While the Cabinet Committee on Economic Affairs has recommended regular coal linkage actions and an increase in the quantity of coal for special forward e-actions, this would require significant ramping up of production and supply by CIL. The estimates are that this increase in output would have to be at least 8% up from the current levels under the assumption of the 16 GW of capacity operating at 50% PLF under short / medium term PPAs.

Considering large hydro plants (of more than 25 MW capacity) also as a renewable energy source is a correction that has been long overdue. The Government has, moreover, notified that it would provide separate HPO targets. This would provide a niche market for Hydro power. Also, unlike thermal plants and very similar to solar and wind power generators, hydro plants have an almost negligible recurring cost. So basically, the entire cost is the capital expenditure which is shared by the developer and the banks.

The capital expenditure has to be recovered over the life of the project. It has been observed that hydro plants have a much longer life as compared to thermal plants or renewable energy plants. The life of hydro plants can be upwards of 50 years if they are maintained properly. The earlier tariff regulations provided for the life of the hydro plant to be considered as 35 years. Further, a major position of the debt repayment had to be done in the first 12 years. All this made the tariff for hydro plants very high & unattractive, especially during the initial years even though the tariff is much lower when seen over the useful life of the project.

So, by making a provision for increasing the life of the project to 40 years, increasing the debt repayment period to 18 years, providing flexibility in the tariff stream & providing aid for building roads & bridges, developers can reduce the tariff & make it attractive for the DISCOMS to purchase hydro power.

While the cabinet measures should help a resolving the stressed assets, swift execution is key to preventing these assets from being mothballed. As regards to other two recommendations pertaining to payment security mechanism involving the bill discounting frame work and reviewing the Gas-based strained projects, power ministry is in discussions with RBI as well as the Oil Ministry to resolve both these issues.

India Energy Forum has been organising expert discussions under its "Urja Vichar Manch programme" to address these issues. Power Summit, flagship yearly one day event have been structuring its programme to address current issues for health of the power sector. This 22nd uninterrupted yearly event will address some of the current issues for viability of the sector.

B. Bhambhani
Convenor, Power, IEF
Former ED, BHEL
Secretary, Steering Committee

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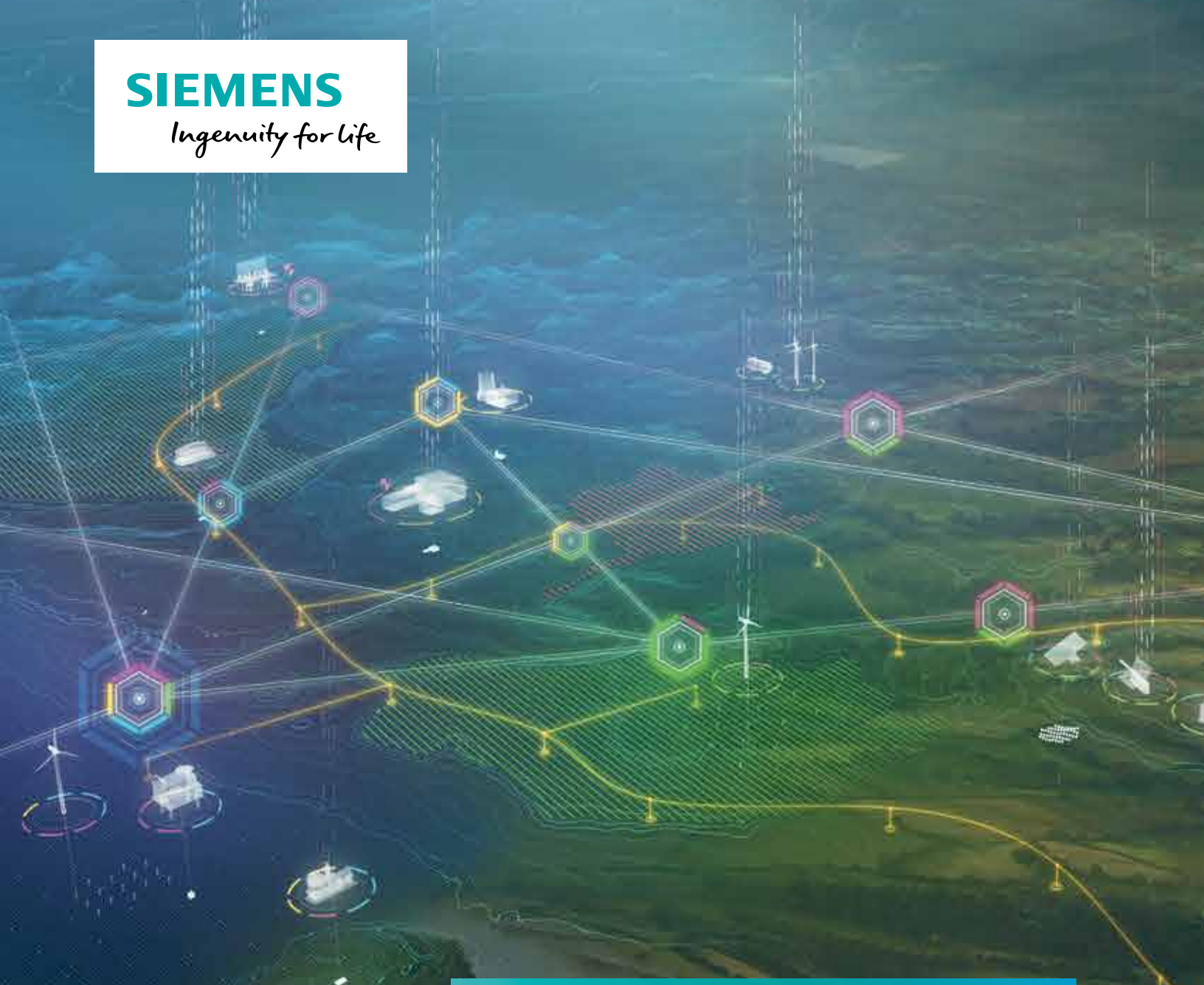

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INDIA ENERGY FORUM

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Theme Paper

Power Sector Agenda Beyond 2020: Challenges and Imperatives

Table of Contents

List of Exhibits

1 Overview of the power sector

As India gears up to move into the third decade of the millennium, with several critical socio-economic goals and targets, the power sector will have to synchronize its performance with the aspirations of the GDP growth. India has recognised the need to strengthen the power sector to support its growing demand for electricity. As a result, India had taken several bold steps to create policy interventions as early as 1990s which were followed by the enactment of Electricity Act (EA) in 2003 and many policy developments across the length and breadth of the sector. The sector currently is in the process of a paradigm shift, moving from a fossil fuel-based economy to a greater reliance on renewables. To augment this paradigm shift, policy makers of India have introduced a host of policies and programmes in the recent few years. Be it the revival of power distribution utilities with the Ujwal Discom Assurance Yojana (UDAY) scheme or the plethora of renewable bids that have been conducted in the country, the developments in the sector have been consistent as well as incessant. The increasing number of start-ups offering battery solutions, electric vehicles, artificial intelligence solutions in power and the growing interest in roof top solutions are some indicators of the flourishing think tanks of the country.

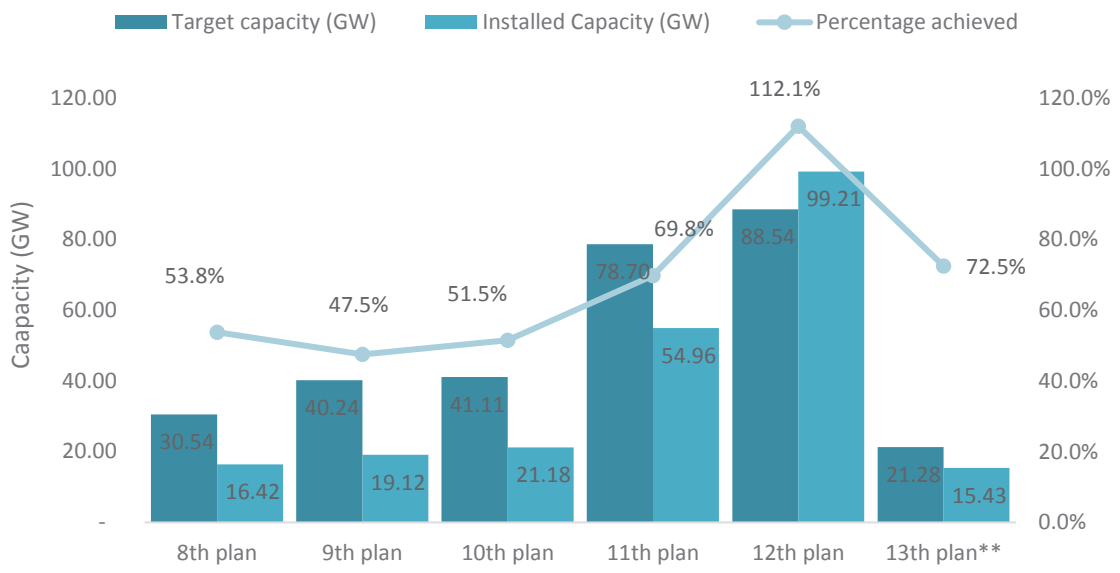
This section presents an overview of achievements made so far, the supply and demand scenario in the coming decade and the challenges which the power sector must meet to support the growth.

1.1 Progress so far

Generation

India's focus on ramping up generation experienced major emphasis in the 1990s with the amendment to Electricity supply act in 1991 and mega power policy in 1995. India's generation capacity has grown multi fold since 1990s and as a result, India is fifth largest power producer in the world behind the United States, China, Russia and Japan. The capacity addition in the last concluded 12th year plan which ended in 2017 has been historic with the addition of 99.20 GW. The target set for the ongoing 13th five-year plan is 117.75 GW. In the first two years of the 13th five-year plan, a capacity addition of 15.42 GW has been achieved vis-à-vis a target of 21.27 GW. *Exhibit 1* provides comparison of generation target capacity vs installed capacity of previous five-year plans.

Exhibit 1: Generation target capacity vs installed capacity

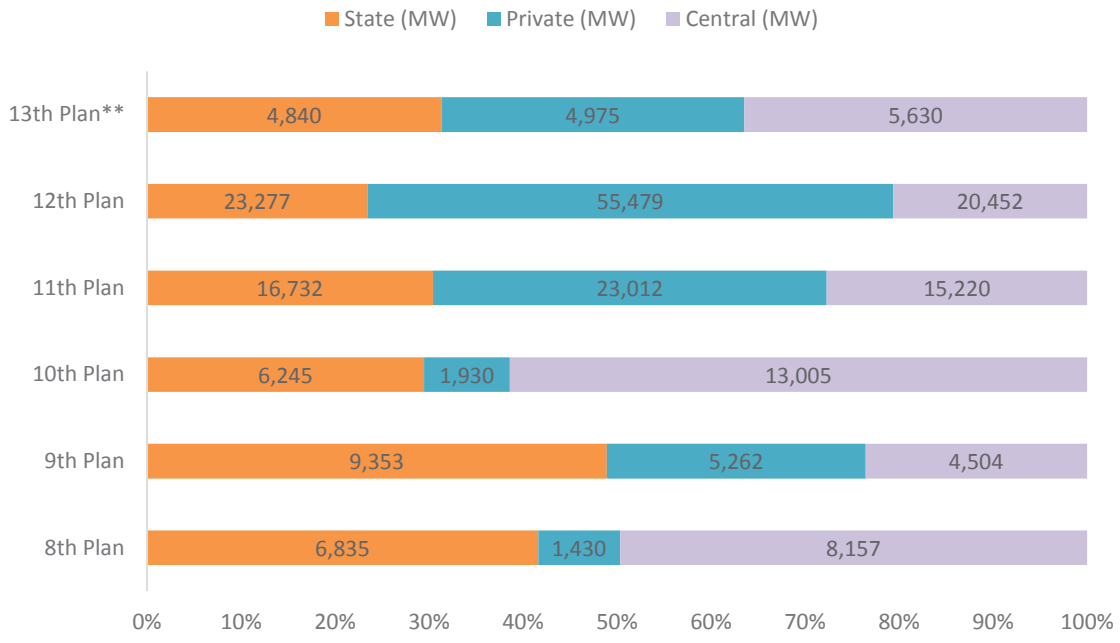


Source: CEA- National Electricity Plan Jan 2018 & Executive summary on Power sector April 2019

*** Cumulative data of FY 17-18 & FY18-19 have been shown in the Exhibit 1*

The private sector has been one of the key contributors to the growth story of India's generation capacity. In the year 1992, the contribution of private sector was a mere 2.5 GW i.e. around 3% of the installed capacity in the country while in the 12th plan, the private sector grew to emerge as the largest contributor in the capacity augmentation with a share of 56%. Over last three decades, a substantial base of private power generators has developed within the country. Majority of them have been large Indian private firms who were working in engineering, procurement and construction domains of power and infrastructure sector as well as companies of other sectors whenever the bidding rules allowed them to participate. *Exhibit 2* illustrates segment wise contribution to country's power generation capacity during previous five-year plans.

Exhibit 2: Segment wise contribution to country's power generation capacity



Source: CEA-National Electricity Plan Jan 2018 & Executive Summary on Power Sector April 2019

***Cumulative data of FY 17-18 & FY 18-19 have been shown in the Exhibit 2*

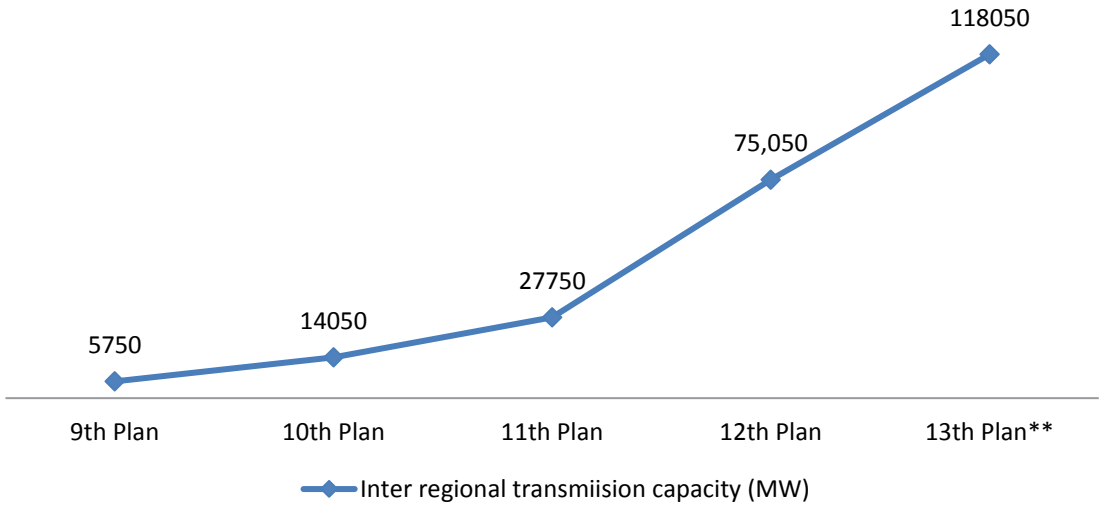
Though India's generation capacity has been largely driven by conventional resources, the addition of renewable energy has gained significant momentum over the past two decades. While grid interactive renewable power was a miniscule 18MW in early 1990s, it has grown multi-fold since then and as per MNRE, it stands at 82.58 GW as on September 2019. The growth of grid based interactive power supply from renewable resources was driven in three steps. First, the introduction of feed in tariff guidelines in 1993, second was with the enactment Electricity Act in 2003 and third the introduction of the Tariff Based Competitive Bidding regime. These measures created market awareness about the potential of supply from renewables which was further aided by regulatory certainty and a standard commercial framework for independent and captive producers.

Transmission

Prior to 1998, the transmission system in India consisted of separate regional grids. It was post amendment to the Electric Supply act in 1998, that the basic framework for coordinated system development was established and private participation in the transmission segment was allowed. India has since then progressed to a nationally synchronized transmission system linking the regional grids to operate at a single frequency with a continuous endeavour to form a national grid.

Capacity planning studies by CEA have frequently observed that the capacity planned on all India basis used to be less than the sum of capacity planned on regional basis. This suggested that there was a scope of continuous improvement in the optimal use of generating capacity in the country. In order to achieve this, integration of regional grids was envisaged which not only enabled harnessing of unevenly distributed generation resources in the country but also reduced system redundancy. Recognizing the need for development of National grid, thrust was given to enhance the capacity of inter-regional linkages in a phased manner. *Exhibit 3* presents the growth of interregional capacity over the previous five-year plans.

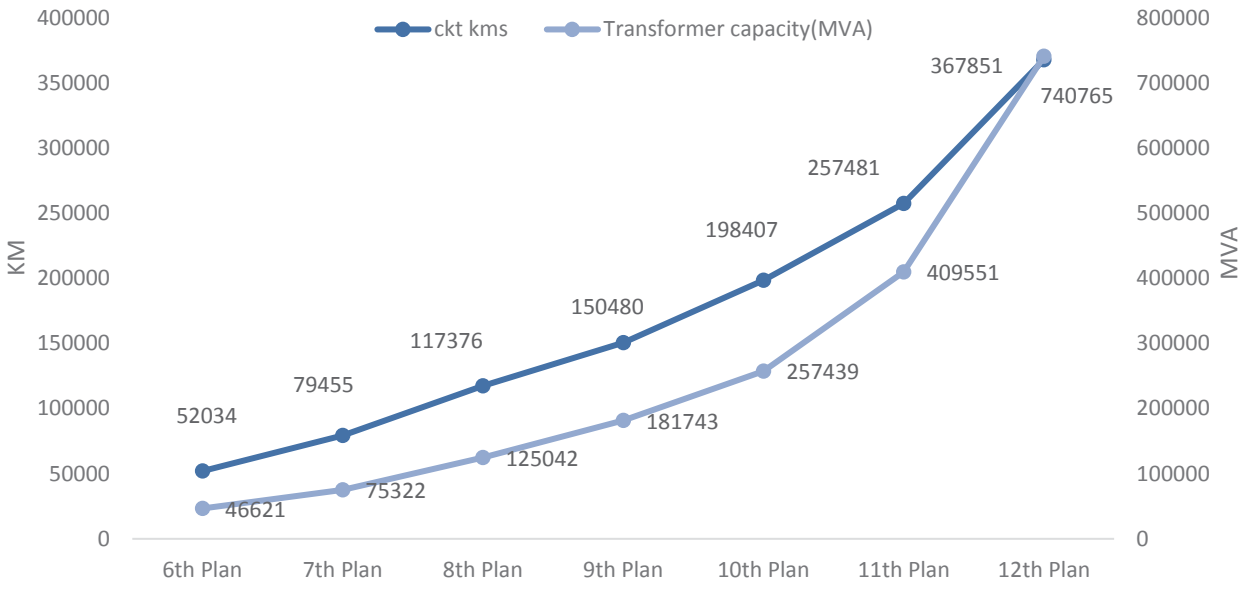
Exhibit 3: Growth of interregional capacity



Source: CEA- National Electricity Plan
***Expected by the end of 13th five-year plan*

Timely intervention by regulatory bodies such as CERC through implementation of point of connection (POC) charges have helped in improving the payment certainty. Significant traction has been observed in private participation in the transmission sector as a result of this certainly which the POC mechanism has brought to the table. Further interventions like amendments to Indian Electricity Grid Code and Unscheduled Interchange (UI) regulation have ensured continuous improvement in safe and secure grid operations. *Exhibit 4* presents the capacity wise growth in the transmission segment during previous five-year plans.

Exhibit 4: Capacity wise growth in the transmission segment



Source: CEA

Distribution

While segments such as Generation and Transmission have performed rather well, the performance of distribution segment almost across the country remains a cause of concern for all the stakeholders. It is also the most vital link between the utilities and the end consumer and forms the cash register for the entire sector. With the unbundling of utilities and the Government pushing for reforms through schemes such as IPDS, UDAY, RGGVY and DDYGJY, it was hoped that there would be turn around in the financial and operational health of distribution companies across the nation. Although, some progress has been made over the years with implementation of Government reforms but still there is much work left to be done.

For instance, the Government implemented UDAY scheme as a measure to ease the financial burden of Distribution companies and now it is working to implement the revised version of it as there was need for further amend the schemes in order to address the woes of the sector more effectively.

It is to be noticed that the schemes like UDAY was implemented so that state could share the financial burden of distribution companies but if the operational inefficiencies such as faulty metering, billing in-efficiencies, etc. continue to exist then many of the State Governments might not be able to share the financial burden of distribution utilities and the central Government will need to share the burden. *Exhibit 5* states the status of UDAY scheme.

Exhibit 5: Status of UDAY scheme

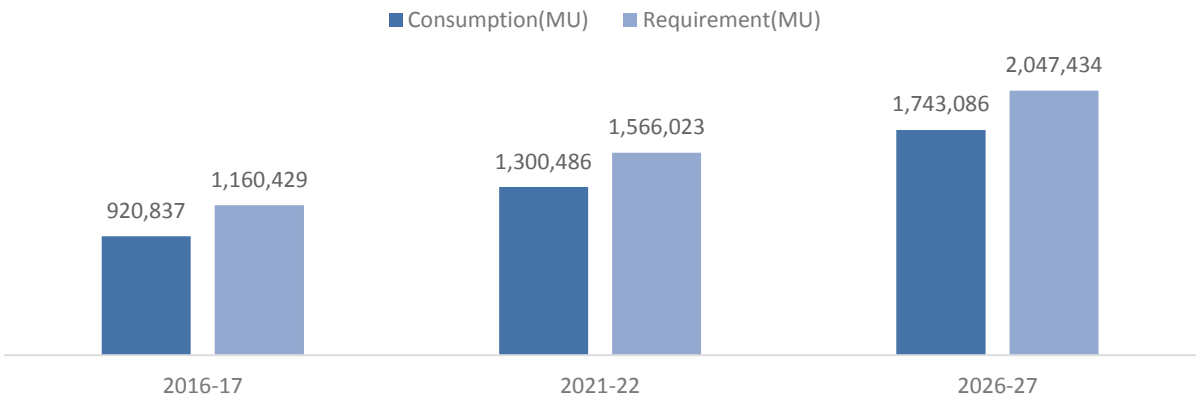
Parameter	Remark
Bond issuance	Total bond to be issued for UDAY states were Rs. 2.69 trillion of which nearly 86.29% of the bond issuance has been executed
AT&C loss of 19 states	22.91%
ACS-ARR gap	Rs. 0.39 per unit
Tariff Revision	Complete for 25 out of 27 states

Source: UDAY website (the data has been taken on 21st October 2019)

1.2 Assessment of power requirements of the country

Electricity demand assessment is periodically carried out by Electric Power Survey Committee (EPSC). The assessment is based on past consumption trends, programmes by government, development projects in pipeline and impact of energy saving schemes. The schemes such as Saubhagya Yogna which aim to electrify every household across the country are factored in along with other projections of energy requirements resulting from industrial growth, demand increase with increase in population etc. and the offset created through energy efficiency measures

Exhibit 6: Consumption vs Requirement of Power



Source: CEA National Electricity Plan 2018

It may be taken note from *Exhibit 6* that the CAGR of electrical energy requirement is 6.18% and 5.51% for the period 2016-17 to 2021-22 and 2021-22 to 2016-27 respectively and the CAGR of energy consumption 7.15% and 6.03% for the same periods.

It may be noted that the CAGR for energy requirement and energy consumption are both reducing. This may be attributed to the implementation of distribution system strengthening

schemes such as IPDS and energy efficiency measures. The billing losses are also expected to witness a reducing curve in years to come. This is also in congruence of targeted 13% AT&C loss by 2021-22 by ministry of power. Several initiatives that have been taken up by the Government of India and State Governments such as demand side management, Perform-Achieve-trade (PAT) schemes for industries, efficient lighting programmes etc. were envisaged to optimize the use of power. As per CEA report of Jan 2018, energy savings of 249 BU and 337 BU are estimated in FY 2021-22 & FY 2026-27 respectively through these measures of energy efficiency. A uniform approach throughout the nation may be taken up through regulatory interventions mandating the distribution companies and providing them the bandwidth to implement energy efficiency measures in their areas of operations. In view of the projected demand for the period of 2016-17 to 2021-22, it is to be noted that with a committed capacity addition of 6,823 MW of hydro, 406 MW of Gas, 3,300 MW of nuclear, 1,17,756 MW of renewables and considering a retirement of coal based capacity of 22,716 MW with demand CAGR of 6.18% during 2017- 22, only 6,445 MW coal based capacity would be required for the said period, whereas coal based capacity of 47,855 MW is at various stages of construction and is likely to be commissioned during 2017-22 . The PLF of thermal projects would be influenced by a score of factors such as capacity addition achieved from RES, hydro and units that are retired by 2021-22.

1.3 Challenges & imperatives

The current decade has witnessed several 'firsts' as a result of many robust initiatives taken by the government in the areas of finance, policy and regulations. While many of these initiatives have already yielded their successful results, others are at least demonstrating that the steps in the right direction have been taken. All these initiatives, if continued with the same level of thrust, are likely to lead to near term revival of the power sector along with its long-term sustainability. However, there are still certain key and contemporary issues that need to be urgently looked into to achieve a comprehensive turnaround and revival. Further, with the continuously evolving sector and technology, there is a further need to ensure sustainability. In the coming decade, some of the key challenges that power sector will need to address are described below.

1.3.1 Decarbonisation and decentralisation

1.3.1.1 Low carbon measures

While the thrust on renewable integration continues, there is a need to simultaneously ensure decreased carbon emissions from thermal units. This would entail the installation of flue gas purification units such as Flue Gas Desulphurisation Plants and De-NOx units. While these

initiatives have already been taken, there is a need to gradually retire inefficient and financially unviable thermal units which have exhausted their useful lives.

Many thermal power generation units which have crossed their operational life are still in operation. Several of them are observed to be performing sub-optimally in current scenario. With high heat rates and having deviations from emission norms, these units are economically and ecologically untenable in the years to come and phasing out of these units is required. The Ministry of Power has planned to phase out such units sequentially as the parallel capacity gets built in the coming decade. Capacity of 35 GW is estimated to be phased out by 2030 in line with idea of retiring inefficient units.

1.3.1.2 Decentralized power systems

The quality of power being delivered to the consumer remains a concern, especially in rural segments. The advent of distributed energy resources can be seen as a significant development in the years to come to improve the quality of power accessed in a cost-effective manner. Such offline mini grids shall compensate for quality of power delivered in far flung areas which in many cases are found wanting for stable power. There have been few pilot projects using solar rooftops in selected rural areas across states of Uttar Pradesh, Bihar, Chhattisgarh and the results are encouraging but there is still long way to go. As the grid supply gets improved with time, the financial viability of such projects needs to be evaluated. There is lack of accurate demand mapping across the rural areas that may prevent investors to build on such projects.

1.3.2 Revival of the distribution sector

The distribution sector suffers from a mix of various challenges which impact their financial position. While the government has been prudent in taking necessary reform measures, there is still a lot work to be done. Actions need to aimed at improving operating performance and financial position.

1.3.2.1 Greater thrust on privatisation/ franchisee model

In order to reduce losses in the distribution network, while discoms have strived hard over the years, there is a need to reconsider privatisation and franchisee models more seriously. While the franchisee models have been received differently in various parts of the country, there is certainly a need to assess the necessary facilitations needed for making distribution franchisee a success.

1.3.2.2 Introduction of real time market

Discoms have been traditionally relying on purchase of power via long term PPAs. As a result of this discoms are generally not in a position to purchase cheaper power available without reneging existing PPAs. Further, the cheaper power available in other states was not accessible

to the discoms. The introduction of a real time market may be useful in bringing cost efficiency to discoms, since power from generators in other states would be available to all discoms. Cost efficiency will bring in financial sustainability to discoms and help alleviating the distress on discoms.

1.3.2.3 Ensuring better corporate governance

Corporate Governance is an important determinant of industrial competitiveness. Nowadays there are many questions raised on the way a company is governed. Better governance ensures enhanced corporate performance and better economic results. Corporate Governance lays the foundation for behaviour of the company, the utilization of resources, product/service innovation and overall corporate strategies.

1.3.3 Addressing stressed power assets

As discussed, post implementation of EA 2003, rapid capacity addition by generators coupled with other issues such as shortage of demand, deallocation of coal blocks, aggressive bidding by few private sectors owners lead to unfeasible financial operation of their projects and created a significant amount of stress in the sector. There are several dues that the distribution companies owe to generators. This has hampered the ability to generators to manage their working capital and consequently their operations have taken a hit. The Government of India had initiated schemes such as SHAKTI for providing coal linkages to commissioned units with no coal linkage and a pilot project to procure 2500 MW from generators with untied capacity. Initiatives have been taken on issues such as fuel, discoms and regulations with the motive of easing the stress that has been created so far. In subsequent section, such reasons, initiatives being taken, and related ideas have been discussed.

2 Decarbonisation & decentralization

The transition to a low carbon future is changing the nature of Indian power sector and there is significant role that power sector must play in decarbonizing the transport sector as well. Further, while traditionally electricity has been flowing from large transmission networks, connected to generating stations through passive distribution networks, to end consumers, advancement of technology in recent years has enabled smaller forms of generators, especially solar ones, to produce energy closer to where it is consumed, thereby reducing T&D losses.

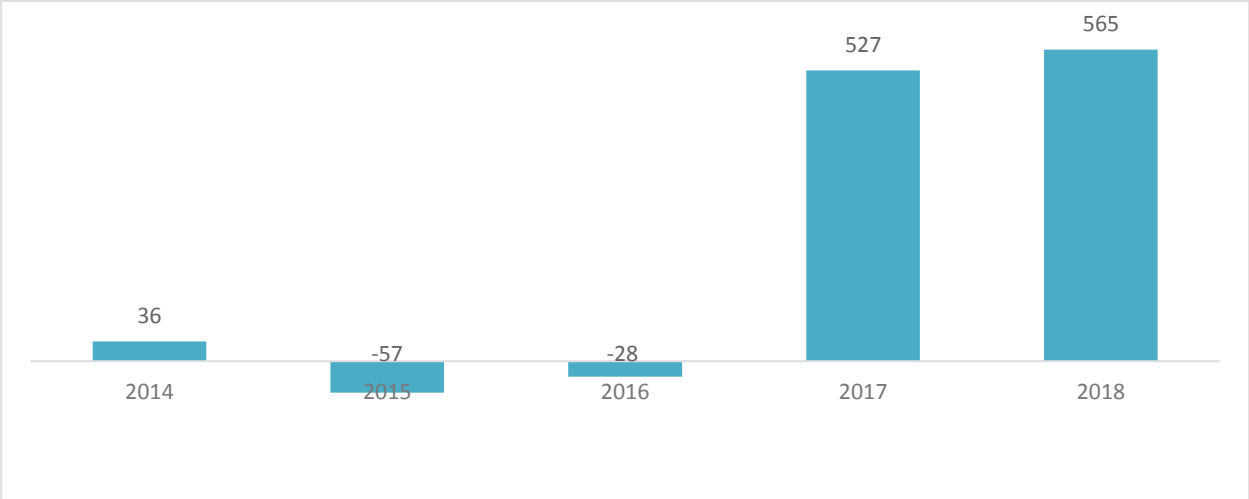
This section captures the implications and imperatives of decarbonisation and decentralisation of the Indian power sector.

2.1 Phasing out inefficient plants

The CO2 emissions in the world have grown significantly in the recent years. Electricity generation from renewable sources increased globally by over 7% in 2018, injecting an additional 450 TWh into global electricity networks. Increasing output from nuclear contributed another 90 TWh of low-carbon generation.

Yet this increase was not fast enough to keep pace with the rapid growth in electricity demand, which required additional generation of over 1000 TWh. The resulting increase in generation from fossil fuel-fired power plants saw the power sector account for almost two-thirds of the increase in total emissions. Without the accompanying decarbonisation of power sector, electrification will not necessarily mean lower emissions. *Exhibit 7* presents the change in global CO2 emissions in the last five years.

Exhibit 7: Carbon dioxide emission- global trends (MT)

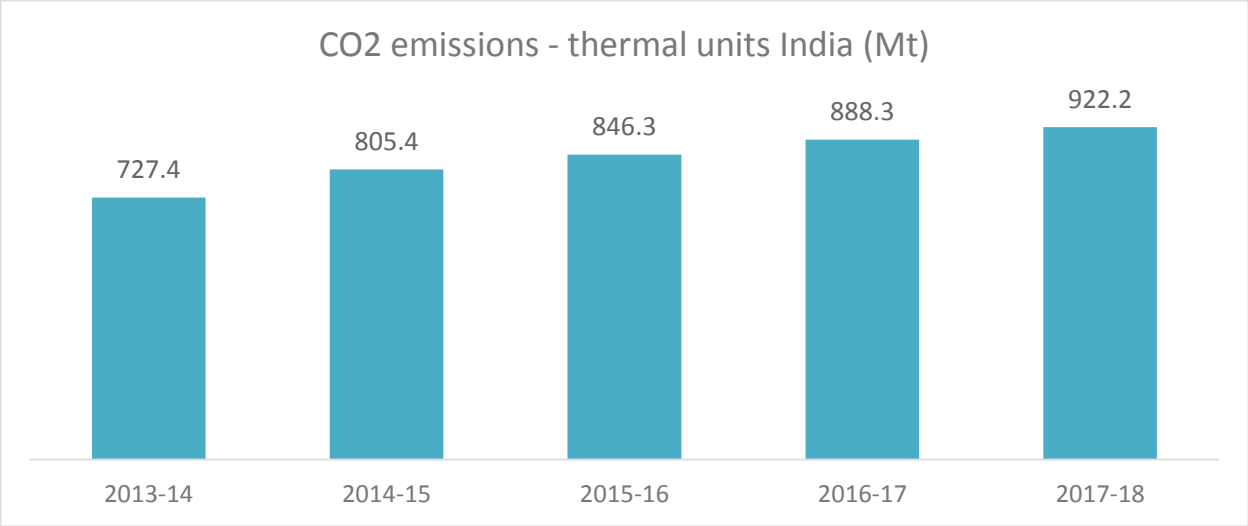


Source: IEA

India's carbon emissions are primarily driven by power sector, other sectors such as transport and industries also contribute significantly. While India is estimated to achieve its ambitious INDC goals of 40% non-fossil based power capacity by 2030 (which is a decade earlier than targeted), it is also to be noted that India's carbon dioxide levels rose by 4.8% or 105 Mt in 2018, with the growth split evenly between power and other sectors such as transport and industry. Despite this growth, per capita emissions in India remain low at only 40% of the global average. However, given the population density in India, the CO2 emissions in India per unit area are concerning.

CO2 emissions from thermal power stations have consistently increased in the last five years. *Exhibit 8* presents the total emission due to thermal power projects in the recent years. However, the rate of emission has remained nearly consistent at 0.82 ton/MWh. Therefore, there is a certain need to work on increasing the efficiency of thermal units

Exhibit 8: Carbon dioxide emission- thermal units, India



Source: CEA

While the thrust on renewable energy persists, India will continue to depend upon fossil fuel based projects for power generation. It is imperative that the efficiency of the thermal units be monitored. While flue gas cleaning technologies are able to reduce the SOx and NOx levels, CO2 levels still need further controls. Therefore, there is a need to not only ensure that emission standards are met, but the station heat rate is optimised.

The MOEFCC had notified new norms in 2015 to be complied by thermal power plants. Compliance to the new norms is possible for thermal power plants only with implementation of technologies like Flue Gas Desulfurization (FGD) and Selective Catalyst Reduction (SCR). This has been a major challenge for old thermal power plants as implementation of these technologies

requires land and disposal of large volumes of by-products generated. Along with this, the auxiliary power consumption also increases by 1%-1.5% which further affects the efficiency of power plants.

With significant increase in generation capacity, there has been reduction in peak power deficit over the past few years. As a result of this, a large capacity is lying underutilized. At the same time there are many old plants in operation which are having higher heat rates and are non-compliant to environmental norms. The specific coal consumption of these plants is also higher as compared to newer plants, which are more efficient. In order to ensure optimal utilization of scarce resource such as coal and produce cleaner energy, inefficient power plants with high heat rates and which are non-compliant towards the environmental norms must be considered for phasing out during the course of next decade. As of now, 8,470MW of inefficient thermal power stations older than 25 years have been retired. In addition to this, the Ministry of Power has identified power plants with a capacity of 10,000 MW to be phased out by FY 22. It is also estimated that a total of 25,572 MW of coal fired power plants shall be retired between FY 23 & FY 30.

Most of the thermal power plant units in India are sub-critical while the share of power produced from Supercritical units being only around 11%. With the focus on implementation of cleaner technologies in generation of power like the commissioning of India's first ultra-supercritical power plant in Khargone in Madhya Pradesh whose efficiency is 3.3% higher than supercritical technology, the long term focus must be on continuous integration of modern technologies such as Ultra Supercritical (USC) and Advanced Ultra Super Critical (AUSC) through indigenous manufacturing.

Coal based power plants will continue to be in service in the coming decades. In view of this, it is important that technology of the generation plants is upgraded so that their operations not only becomes economical but also follow the emission obligations.

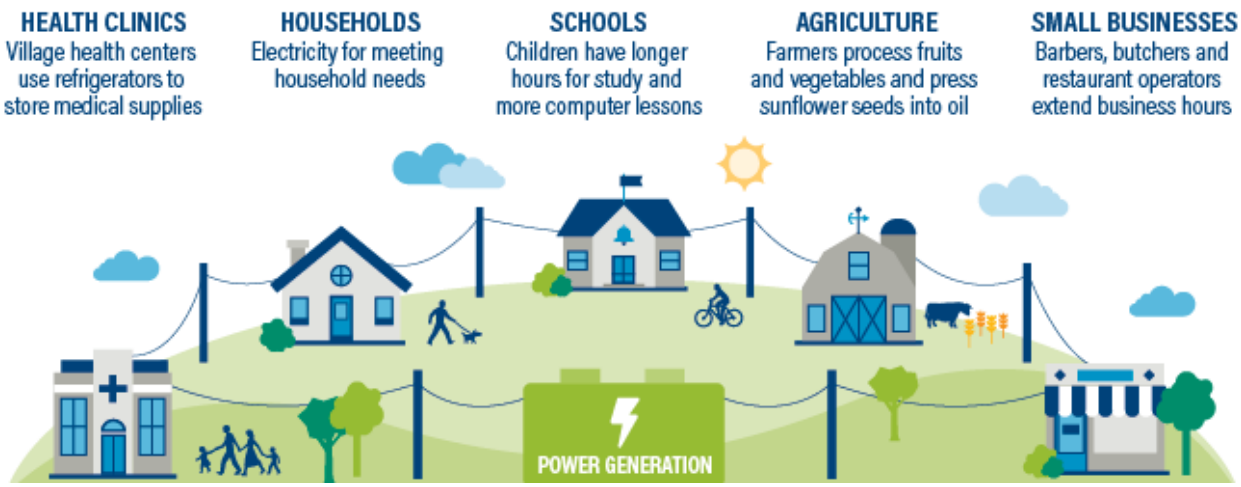
2.2 Distributed Energy Resources

As per estimation by World Energy Forum, fossil fuel based resources may be exhausted in another ten decades. This, coupled with the adverse effects of climate change, has made the policy makers to looks towards renewable sources of energy. Decentralized renewable systems uses renewable resources to generate, store and distribute energy at a localized level. These may include smaller generation and storage resources that may feed to isolated distributed networks.

India initiated Saubhagya scheme in 2017 with the aim to ensure electrification of more than 26.3 million un-electrified households across the country and to complement the DDUGJY scheme which was brought to strengthen electricity infrastructure in rural areas. At the end of FY

2018-19, data released by Saubhagya scheme portal mentioned that out of 26.3 million rural household, only 18,734 were left un-electrified that too belonging to the state of Chhattisgarh. However, having an electric connection does not necessarily translate into having a reliable power supply and lack of qualitative supply of power have forced the rural population to use sub-optimal sources of lighting such as kerosene. Decentralized renewable systems such as solar roof top systems can complement government's effort to ensure 24-hour electricity access in the coming years. As such systems become more affordable, rural populace will be encouraged to use the mini grid connections for their lighting mobile charging, fans and other household appliances. Another reason for adoption of mini grids in rural areas is that they provide continuous power solutions especially during evening hours in remote villages when supply from centralized grid may not be always available.

Exhibit 9: Mini-grid schematic



Source: World Resource institute

Although such decentralized renewable systems are well known to complement the centralized grid and contribute towards the quality of power supply to the rural consumers, there exists certain knowledge gaps that pose challenge to the expansion of such solutions. Issues like accurate estimation of demand of power and quality of supply at rural communities' level is still not mapped across the majority of the country. Along with this, consumer's willingness to adopt and pay for connections for such systems is still not reliably estimated. These aspects have significant implication on identification of target location for expansion and financial viability of such projects.

3 Revival of the distribution sector

The health of distribution segment has remained a concern for all stakeholders for a long time now. The Central & State governments have implemented several schemes such as UDAY, IPDS, Saubhagya etc. to assist distribution companies in overcoming their financial challenges and improve the operational efficiency. While there have been few positive offshoots, the concerns still remain and now Government is planning to implement the revised version of UDAY for better results. While there has been improvement in parameters such as AT&C losses and access to power, several issues such as metering & collection and subsequent dues to generators continue to create financial stress in the segment. Regulatory reforms in terms of DSM to promote efficiency, technology such as smart grids and metering to prevent theft and improve collection should be seriously explored to overcome the situation. Reforms in distribution franchise model may also be looked at as the allocation provided by Central Government currently is not accessible to such franchises. There are issues attached with power procurement mechanism and despatch. The self-scheduling/MOD mechanism prevalent in which distribution companies have contracted PPAs with a set of Generators prevent utilities from discovering cheaper power available and thus they are bound to procure power at a higher tariff. Institutions such as CERC have ideated on this issue and have opined that measures such as Real Time Market may be looked at to create to more dynamic power market in the country. However, there are challenges to bring about such measures where all utilities, state governments and central government must be in agreement as this shall involve renegotiation of many existing PPAs.

As the issue of power is a concurrent subject, states are responsible to implement the centrally designed mandates. With the implementation of Electricity Act 2003, a new paradigm for power sector was put forward emphasizing on restructuring of utilities and creation of regulators. The implementation of EA was aimed at introducing structural changes in power sector such as introduction of private utilities, accountability and financially viability of utilities, improving quality of service, deeper access of power and promotion of renewable energy. The schemes that followed up after EA were designed to promote efficient performance of the sector. For instance, UDAY was designed and implemented to reduce debt burden on state utilities, the next leg of UDAY is expected to aim at issues like technical interventions and theft reduction.

3.1 Privatization and franchising of utilities

Franchising has become a globally accepted business model especially in private sector. It has been ten years since the inception of first power distribution franchise in Bhiwandi in India. Inefficiencies in power distribution have been the weakest link in Indian power supply chain

since a long time. Issues like power theft, billing inefficiencies and regulatory delays have been affecting the financial health of the Utilities and while the Government's UDAY scheme seem to reduce the losses, much still needs to done to improve the sustainability of power distribution companies.

While there has been improvement in the performance due to the implementation of franchise model, there have been various constraints which have prevented the widespread implementation of this model. The bid structure in most of the cases does not provide required economic benefit to the bidder. The franchise contracts may not provide the bidder with an extension clause and thus the incentive required for continued investment is distribution network is lacking. Another aspect with regard to capital investment is that the mechanism of funding from central government's schemes to franchises is not available on most occasions. As mentioned, Bhiwandi was the first case of franchise-based distribution model in India and it was subsequently followed by other private players who ventured into the business model in other towns across the nation. For instance, Essel utilities took up distribution franchise work of the city of Nagpur in 2011 from Spanco. At that time the AT&C losses were in around 35% and by 2017-18 they were reduced to 14.5%. The same firm took up franchise assignments in towns Sagar, Ujjain and Gwalior but had to eventually withdraw operations from all three centres after the business became untenable for them.

The franchise model, despite providing better result, has witnessed a mixed reaction from the industry. Although the EA 2003 has included provisions to encourage private participation and bring in competition in the sector, there have been legacy issues which have made franchise only a limited success till now. Issues like un-attractive profit margin and bid structure, risk allocations mechanism and flexibility in operations are needed to be addressed. In current scenario, with implementation of schemes like UDAY and IPDS, the franchise model can certainly be one of the relevant solutions to the operational woes of the distribution segment provided the issues attached with the business model of it are taken care of.

Industry experts for some time now have voiced a need that the institutional structure in the distribution sector is essential for the turnaround of the power sector. Though privatisation has begun some time back in the distribution sector in India, not many visible players have made it big. Financial losses incurred by discoms are result of power theft, billing inefficiencies and regulatory delays in tariff increases.

Privatization can be a possible solution to overcome the sector's commercial challenges. Various private utilities such as Calcutta Electric Supply Corporation in Kolkata, erstwhile Reliance Distribution in Mumbai and Torrent Power in Gujarat were established prior to the enactment of the Electricity Act, 2003, and attempts were made to privatize state-owned utilities. Private participation will bring in operational autonomy in the sector, along with innovation to

improve power distribution. Besides, innovative distribution models such as integrating existing decentralized microgrids in remote areas with utilities to assist in pan-India household electrification can be explored. Despite potential benefits of privatization, there is scepticism owing to mixed results in the past.

To improve billing and collection efficiency stand for co-opting private sector participation seem vindicated. Recent experiences also reinforce the same and present a strong case for a franchise model in distribution. For instance, Feedback Energy Distribution Company Ltd (Fedco) is operating as a distribution franchise in select areas of Odisha and has been able to bring down AT&C losses since 2012-13. Similarly, Torrent Power has continued to substantially improve the network and reduce AT&C losses in Bhiwandi and Agra. The AT&C losses reduced from 22.22% in FY 2016-17 to 17.28% in FY 2017-18 in Bhiwandi and from 26.78% in FY 2016-17 to 20.89% in FY 2017-18 in Agra.

There is a need to further unbundle the distribution companies in smaller discoms/franchisees which would restrict the number of connected consumers thereby facilitate focused actions. Cues can be taken from the distribution service operator (DSO) model being used in Europe. Europe is home to close to 2500 DSOs with majority of them catering to less than 1 lakh consumers. DSOs with higher number of consumers are unbundled. Notwithstanding the stark demographical and economical differences between India and Europe, it is pertinent to take cues from Europe's model and create a distribution franchisee model which is adaptable to India. The model should be accommodative and flexible depending upon the consumer mix and the other socio-political factors. The interest of the participants should be kept in mind to ensure the success of a scheme of this nature. Most importantly there would a need to ensure transparency between stakeholders in terms of billing and collection data.

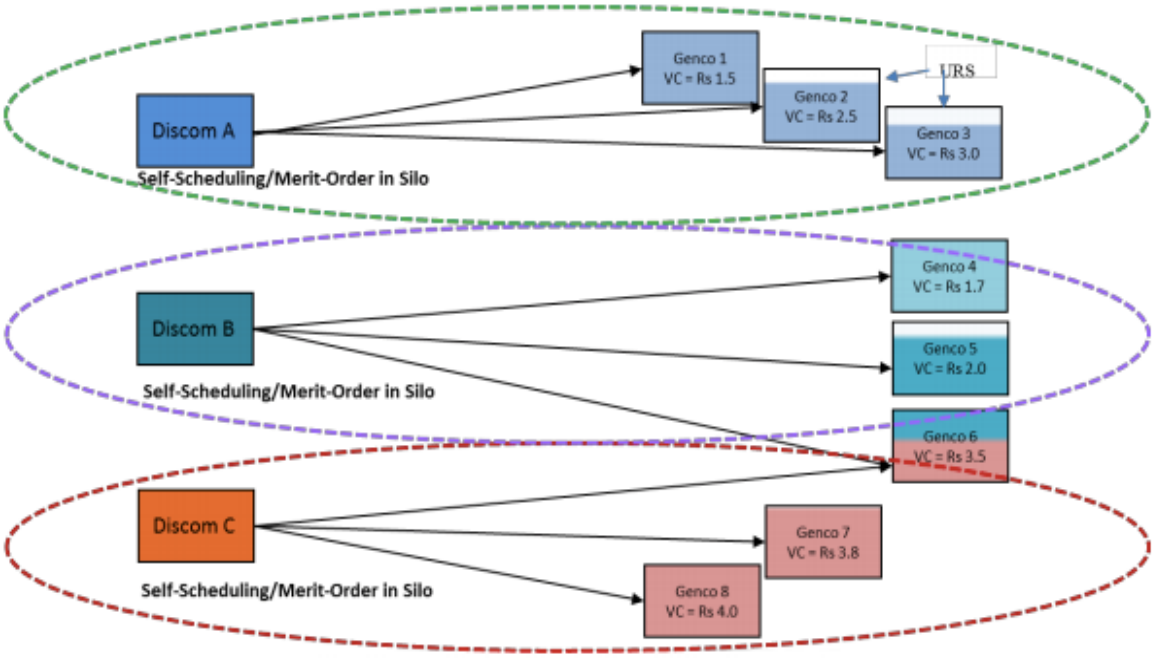
Furthermore, PPP model of distribution, such as 'management operator' is emerging in this space. Fedco is the first company to implement the management operator model and has entered into an agreement with three discoms of Madhya Pradesh to provide the management operator model of distribution across five divisions of the state. The distribution sector is well poised for a structural change; immediate policy initiative is needed for long-term gain.

3.2 Introduction of real time market

A major issue that needs attention of reforms is the inefficient market design. Currently 87% percent of power transactions take place in the country through long term power contracts while national power exchanges make up for less than 4% of power transactions. This prevents discovery of efficient price in the market with distribution companies having to self-schedule with the portfolio of generators with whom they hold these long-term contracts.

Exhibit 10 presents self-scheduling scenario of distribution companies with the generators with whom they contracted long term PPA with the dispatch being based on merit order. The power procured is inclusive of the variable cost which may vary from one generator to other depending on the performance of the plant, coal price etc. This gives little visibility to distribution companies to look for cheaper power in the short-term markets and along with that long term PPAs are also correlated with forecasting of demand which is seldom accurate. For instance, as shown in below exhibit the Discom A has a contracted PPA with a set of generators 1, 2 & 3, in which Genco 2 & 3 have a higher variable cost than other generators such as Genco 4 & 5. This limits the possibility of Discom 1 to discover a lower tariff for itself. Similarly, the Discom C is availing power from generating units whose variable cost is also higher than other generators such as Genco 4 & 5.

Exhibit 10: Self-Scheduling MOD of Discoms



Source: CERC Analysis

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This offers little flexibility to distribution companies to choose from cheaper generators outside their portfolios. Absence of this visibility also often leads to curtailment from variable generation sources like renewables. Currently the distribution companies have an outstanding due in excess of 5.5 billion dollars to generators and the value of stressed assets being in excess of 43 billion dollars. This has created tremendous stress in the country's financial system as the banks and investors are struggling to recover investments in such projects. In addition to this, the cost of

new projects has gone up owing to the risk perception as the financial institutions are lending at higher interest rates.

A framework for national electricity market needs to be developed with advanced features like real time dispatch with synchronised ancillary services procurement. A real time dispatch enables generators to sell their unutilized capacity anywhere in the country and thus squeezing the gap for the distribution utility of what they may want to procure. This shall correct the mismatch of demand and supply, thereby improving the scheduling and despatch process. As variable energy resource increases, having ancillary services is important as these would synchronise with real time markets allowing additional power producers to despatch their capacity and maintain quality of supply as well if a large power producer goes offline.

However, operationalizing such a market is not going to be an easy measure as all state governments and their utilities need to brought on board by the central government. Challenges such as technical alignment of system operators, synchronised software etc. need to managed as well as renegotiation of long-term contracts between generators and distribution companies as and when it shall be needed has to be carried out.

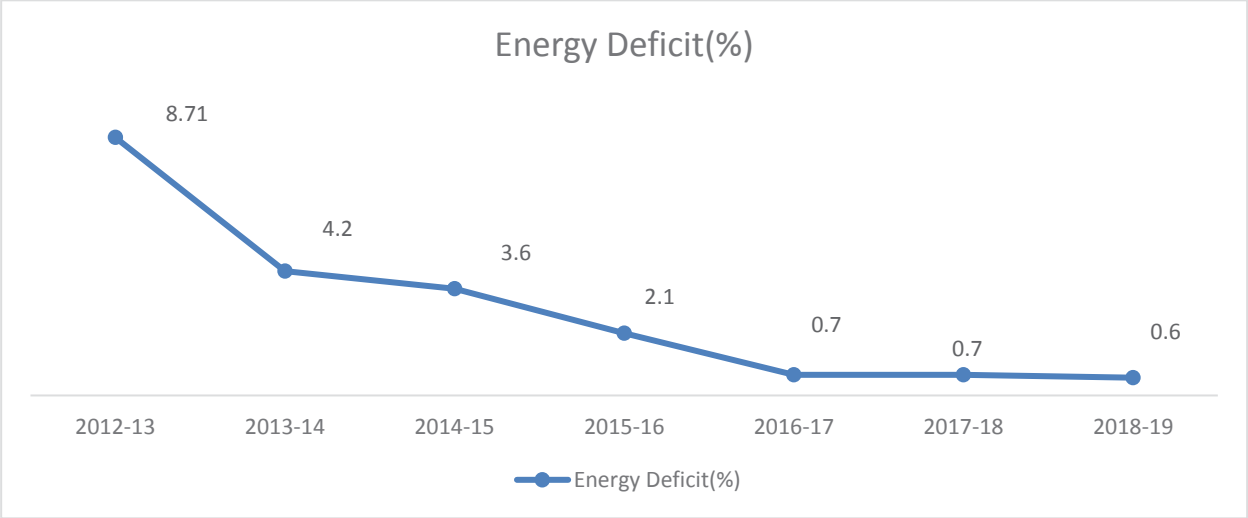
3.3 Corporate Governance in Utilities

The potential benefits of professionalizing utility boards, rationalizing number of executive directors and bringing in the required number of independent directors as prescribed in the guidelines of department of public undertakings need to be underlined and analysed. The Central and State government must bring in utilities to comply with these guidelines and moreover the appointment of independent directors should involve representative of institutions like CEA or other members from public interest to create a more inclusive and transparent process. Beyond this, the relation between the Utility and the Government should be at arm's length distance such that agreements between Utility and State Government for penalising or incentivising are based on performance of the utility and they are available for public scrutiny and third part verification.

4 Stressed assets

The Electricity Act 2003 brought many path breaking reforms in the power sector. Removing the need of license for generation and encouraging private investment were few among them. As a result of these reforms, the augmentation of power generation capacity happened rapidly in last few years and the total generation capacity stood at an excess of 363 GW by the end of September 2019 out of which 147 GW i.e. 45.48% was set up by the private sector. This capacity augmentation has led to sharp reduction in energy deficit over the past few years as can be seen in *Exhibit 11*.

Exhibit 11: Energy deficit over the past years



Source: CEA

However, the rapid expansion in capacity has outpaced the demand and the effect of it can be seen through the PLF. The overall PLF of thermal unit has declined from 78.8% in 2006-07 to 59.88% in 2016-17 which is indicative of underutilization of installed capacity.

High capacity addition with underutilized capacity, lack of PPA, inability of distribution companies of paying the dues, issues of coal linkages have all contributed to the stress created in the power sector. As per the November 2018 report of High-level Empowered Committee (HECL) constituted by Government of India, there are thirty-four stressed power projects with a capacity of 40,130 MW. Few key reasons behind the stressed caused have been discussed as below

Slower Growth in Economy: The stress created can also be attributed to slower growth in demand than what was expected. There has been a general slowdown in global economy and its

effect has been felt in India as well over the last few years. For instance, during the first quarter of the current fiscal year industrial states such as Maharashtra and Tamil Nadu have experience weak growth in power demand at 1.4% & 2.7% respectively. Other manufacturing hubs such as Gujarat and Haryana also witnessed weaker growth at 2.9% and 5.3%. There has been subsequently lower than anticipated power supply and that has left significant capacity underutilized.

Coal Supply: After cancellation of coal blocks in 2014, many power plants were left stranded without coal linkages or were set up without a coal linkage resulting in a higher cost of production.

PPA with Distribution Companies: There have been delays in payment of dues from distribution companies constraining the ability of the generators to service their debt. There has been a dearth of long term PPA which has again led to underutilization of the capacity and in some cases distribution companies have pressed for renegotiation of existing PPAs.

Aggressive Bidding: Many private sector project developers have quoted very aggressive tariff which were not sustainable in long run and caused erosion of equity and inability to service the debt obligations.

In view of the issues discussed above, several steps have been taken by Government of India to ease the stress and plug the leakages in the system. Implementation of schemes such as SHAKTI, rationalization of WPI of coal by CERC, third party sampling of coal, optimization of coal linkage to reduce cost of transportation are some of steps adopted so far at increase availability of fuel to generators.

In order to address the problem of lack of Power Purchase Agreements (PPAs) in the country, Ministry of Power has notified a scheme for procurement of 2500 MW on competitive basis for a period of 3 years from the generators with commissioned projects having untied capacity. PFC Consulting has been appointed as the nodal agency for conducting bids for 2500 MW of power. Bids have been received from 7 (seven) projects for aggregate power of 1900 MW. Based on the same, MoP has decided to introduce the Pilot-II for another 2500 MW. This will potentially improve the financial viability of the power projects and help developers in serving the debt obligations.

Launching of application such as PRAAPTI for increasing transparency of payments between generators and distribution companies have helped sort out issues such as delayed payments and underutilized capacity of generating units.

In addition to the above measures, other ideas such as permission to generators to avail the coal linkage even if the PPA is terminated due to payment delays need to be looked into. A national PSU such as NTPC can act as an aggregator and procure power from stressed units to serve its existing PPAs who have untied capacity till its own under construction units get commissioned. Effective implementation of late surcharge payments on distribution companies also needs to be carry out to ensure proper cash flow in books of generators.

There is a need for reallocation of coal from less efficient and ageing thermal units to modern, efficient and newer thermal power plants. Reallocation of coal from such older units that have already gone much beyond their payback period as well as their technical life, to newer and more efficient plants will not only increase coal availability, but also help reduce emissions. Such interventions will also lead to reduction in overall logistics costs of transporting coal from mines to power plants as the newer allocations can be planned in a more efficient manner. This will not only benefit upcoming plants, but also improve financials of the existing plants by reducing their costs.

To adequately address the assets that are stranded due to financial reasons, a central PSU can be made a nodal agency for taking over the such plants and operating them. This is similar to the concept being utilised in the construction industry where NBCC has been given the responsibility of taking over all the incomplete residential plots and compete construction.

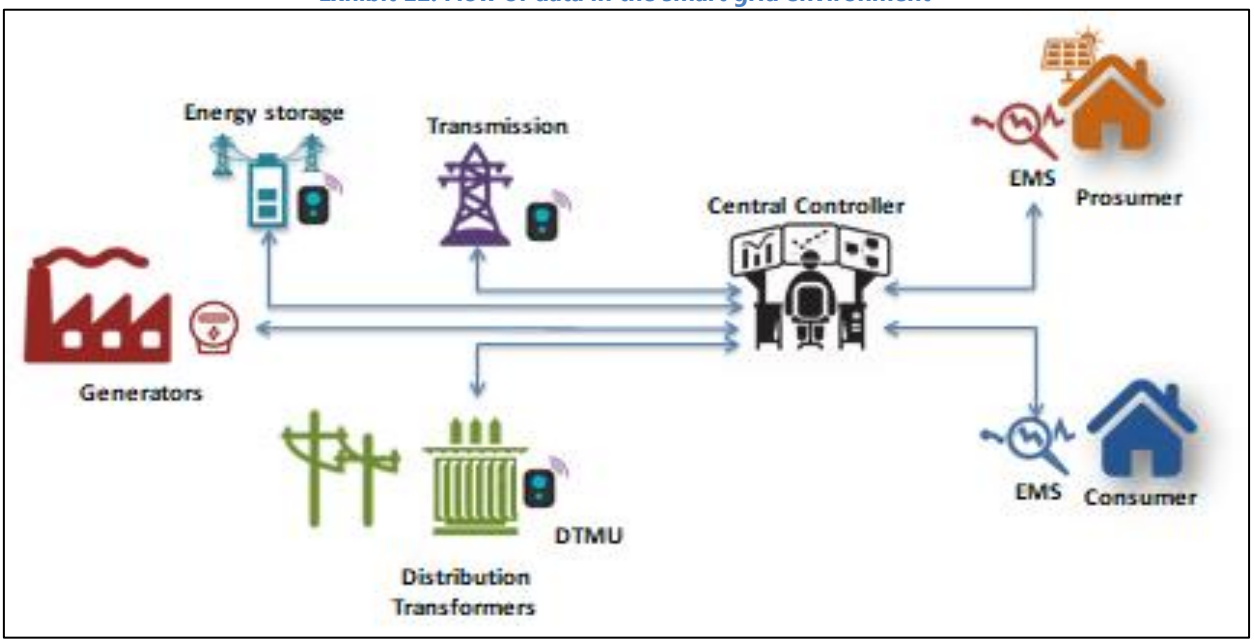
5 Foreseeable trends

The power sector in India is actively pursuing the modernization of the conventional power system through broad range of efforts and initiatives in distinct areas. However, many of these initiatives are either at pilot stage or at inception stage. While comparing with international countries, majority of European and Western countries have already modernized their power systems. Presently, they are actively focusing on adoption of advancement in information technologies, communications, controls, machine learning and other new innovative technologies to provide intelligent grid solutions. The Indian power sector is still at a nascent stage in adoption of these technologies with fulfilment of pre-requisites such as network upgradation, regulatory, policy, etc.

5.1 Smart grid

Smart grid is the modernization of existing electrical network through application of innovative technologies such as smart meters, AMI, SCADA, demand response, etc., in order to improve reliability, security and efficiency of the electrical system. It enables bidirectional digital communication between the consumers and utilities. The implementation of smart grid features leads to enormous data which helps in better forecasting and scheduling of generation, automatic and real time management of the connected load, better management of consumption, etc. Smart grid feature is the precursor to the adoption of advance technology in the future grid. *Exhibit 12* represents the flow of data in the smart grid environment

Exhibit 12: Flow of data in the smart grid environment



India has 5 Smart grid projects in pipeline and has successfully implemented 11 pilot projects as on July 2019. *Exhibit 13* presents the details of smart grid projects in India.

Exhibit 13: Smart grid projects in India

Project	Functionalities	Consumers
CED, Chandigarh (Sub Div-5)	AMI, DTMU, SCADA	0.3 lakh
CED, Chandigarh (Complete City Excl. SD-5)	AMI, SCADA, DTMU	1.84 lakh
JBVNL, Jharkhand (Ranchi)	AMI, DTMU	3.6 lakh
OPTCL, Odisha (Rourkela)	AMI, SCADA, DTMU	0.87 lakh
KSEB, Kerala (Kochi)	AMI, PLM, DTMU, EVCI, PV	0.9 lakh

Exhibit 14: Indian and International Experiences of smart grid projects

Indian Experience

Ajmer Smart grid project: The Capital expenditure of the AVVNL project was Rs. 67 Lakhs. The annual savings of Rs. 13 lakhs was estimated for thousand consumers with a payback period of 5-6 years.

TPDDL ADR project: TPDDL implemented 17 Demand response events in 2014 over 161 Commercial and Industrial consumers with sanctioned load of 63MW. The program achieved a maximum load shifting/shaving of 7.2 MVA and average of 5.09 MVA against

International Experience

Europe: European Union (EU) has invested about 5 billion euros in 950 smart grid projects since 2002 of which lead investors are DSOs (Distribution System Operators) followed by Universities and OEMs. A 2014 European commission report on Deployment of smart metering estimated benefit of 3% average energy savings.

Florida, USA: Florida Power & Light (FPL) upgraded the grid to smart grid with features including GIS, outage management system and distribution management system. The recent experience shows that the smart grid infrastructure has been successful in preventing storm related outages and also helping in faster restoration of power to consumers.

Oklahoma, USA: Oklahoma Gas and Electric Installed 823,000 smart meters, in the initial run it was found that there was reduction of energy use at peak periods up to 33%.

Presently, the smart grid implementation in India is at preliminary level and only certain features such as smart metering, data capturing, etc., are operational.

Exhibit 15 below represent the different levels of Smart grid features.

Exhibit 15: The different levels of Smart grid

Levels	Basic Level	Intermediate level	Advanced level
Functions	Data Capture and Monitoring	Data Analysis and Control	Fully Smart
Features	▪Smart metering including AMI ▪Distribution Transformer management Units (DTMU) ▪Data visualization systems (Ex. Home Displays, dashboards, Apps, etc.)	▪FLISR (Fault Location, Isolation and Service Restoration) ▪SCADA & Power Quality management ▪Load Transfer and line loading analysis	▪HEMS (Home Energy Management Systems) / Smart Home ▪VPP, Substation & Distribution Automation ▪Automated Demand response systems ▪Outage Management & FLISR

5.2 Artificial intelligence

Artificial intelligence refers to the ability of machines to exhibit human-like intelligence. AI is a new emerging value creation opportunity and has a potential to provide a competitive advantage to a wide range of sector.

AI with heightened computational power, supportive Big Data and improved machine learning techniques provides an effective platform for data mining and analytics. Power industries around the world have started shifting from conventional technologies to innovative technologies such as smart grid, smart homes/cities, demand response, etc. to optimize their resources and balance demand-supply situation. These smart technologies generate huge data that can be analysed and could further help in enhancing the output of utilities. The industry is now increasingly investing in AI for analysing the data available not only to deliver proactive infrastructure maintenance, predict equipment failures, minimize losses but also for better customer service. The utilities are exploring ways to employ the AI technologies and to leverage the advantages it offers. Some of AI application in Generation, Transmission and Distribution sector as well as in consumer's segment is described in *Exhibit 16* below.

Exhibit 16: Applications of AI in different segments

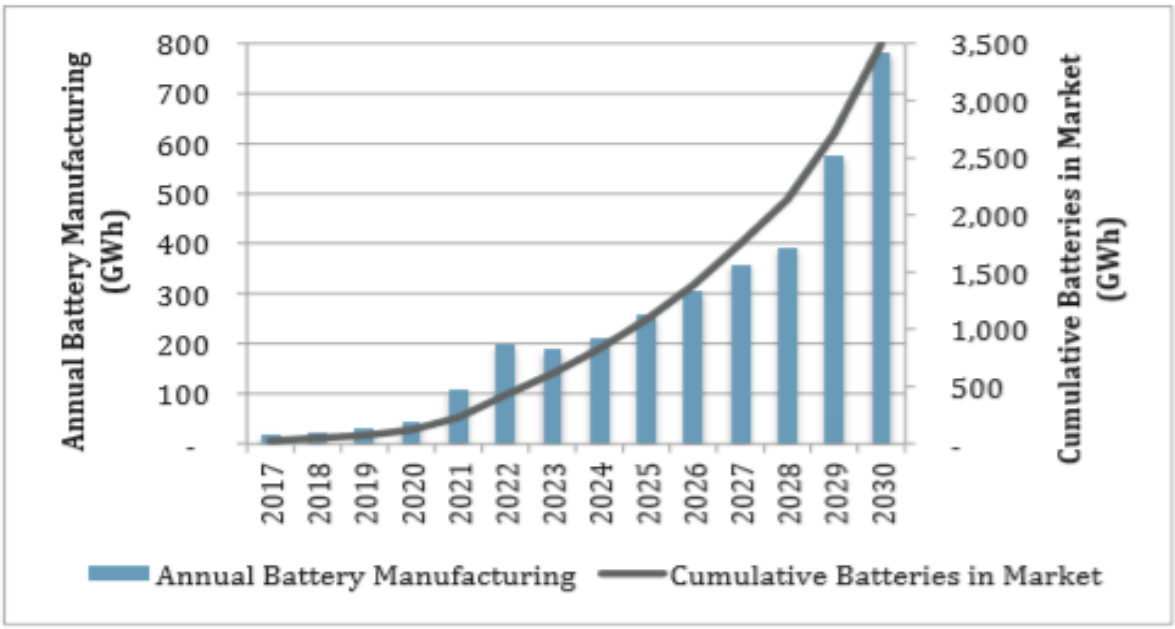
Generation	▪ **Generation planning** - Accurately forecasting and scheduling generation with real-time data monitoring and adjustment. ▪ **Energy trading** - analyzing market data, Weather data, etc., with algorithm & machine learning for better yield optimization.
Transmission	▪ **Asset life cycle management** – deployment of smart sensors & equipment on assets for asset performance management, asset planning, etc. ▪ **Predictive maintenance** – Use of image recognition & drone technology, machine learning, etc., to minimize maintenance.
Distribution	▪ **Theft Reduction** - By monitoring usage patterns, customer history, payment records, etc. ▪ **Load forecasting** – use of machine learning to optimize load dispatch with real-time data ▪ **Predictive maintenance** – Use of image recognition & drone technology, machine learning etc. to minimize maintenance
Consumers	▪ **Energy bills reduction –**Analysis of market data, grid data etc. to shift load/ consumption pattern. ▪ **Usage visibility** - Analysis of meter data to determine consumption pattern, future demand, etc. ▪ **Supplier selection** – Analysis of customer data to choose energy supplier. ▪ **Energy Trading** – Analysis of market data for load dispatching.

5.3 Energy Storage

In line with its aspiration to achieve 100 percent electric vehicle (EV) sales by 2030, India can rise among the top countries in the world in manufacturing batteries. To do so, however, will require a strategy designed to overcome India's relatively weak initial position in battery manufacturing while claiming an increasing share of total battery value over time. As per report by NITI AAYOG, India's market for EV batteries alone could be worth as much as $300 billion from 2017 to 2030. India could represent more than one-third of global EV battery demand by 2030 if the country

meets its goals for a rapid transition to shared, connected, and electric mobility as presented in *Exhibit 17* below.

Exhibit 17: Project Battery Manufacturing Capacity



Source: NITI AAYOG & RMI report

As per report from NITI AAYOG and Rocky Mountain Institute, since the battery today accounts for about one-third of the total purchase price of an EV, driving down battery costs through rapidly scaling production and standardizing battery components could be a key element of long-term success for India's automotive sector. India's EV mission could drive down global better prices by as much as 16 percent to $60 per KWh. Given the projected scale of its domestic market, India could support global-scale manufacturing facilities and eventually become an export hub for battery production.

Development of India's battery manufacturing industry can move stage by stage to achieve its goal of global leadership in battery manufacturing. Developing battery pack manufacturing capacity and establishing a multi-stakeholder research and development consortium followed

by scaling supply chain, capitalizing on research and development, and realizing the benefits of the consortium-led approach to set strategy and planning for battery cell manufacture.

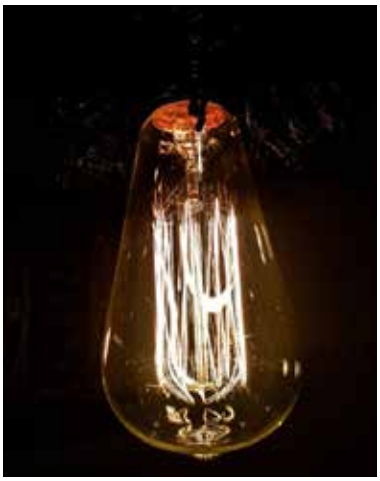
India's 100 percent EV goal must overcome certain challenges in order to successfully meet the timeline of 2030. India has small reserves of key minerals required for lithium-ion (Li-ion) batteries. In Li-ion batteries, cathode materials vary, but common formulations include minerals such as lithium, aluminum, cobalt, manganese, and nickel, while the anode is made of graphite. India does not have reserves of some of the most important Li-ion components including lithium, cobalt, nickel, nor, for that matter, of the copper used in conductors, cables, and bus bars. In order to achieve large-scale domestic production of EV batteries, India would likely need to forge international partnerships and ventures to secure access to key minerals in line with its battery technology and chemistry roadmap. Options for supply chain development will need to be considered based on assessments of battery chemistry and likely scaling of production. Beyond this India has no major producers of EV batteries at present and lacks state-of-the-art facilities of both sufficient capacity and capability. Assembling battery packs from imported cells in India can reduce the cost and internalize more of the value of the battery, as well as build self-reliance to meet domestic pack demand as domestic cell manufacturing ramps up. Further Due to the uncoordinated efforts by different stakeholder groups and the relatively nascent stage of battery manufacturing in India, investment risks in this sector are high. Due in part to the absence of clear long-term policies for manufacturing and uncertainty around future battery technology, battery and vehicle manufacturers hesitate to make significant investments. Consistent and transparent policies can help address this barrier.

INDIA ENERGY FORUM

GOVERNMENT OF INDIA
MINISTRY OF POWER

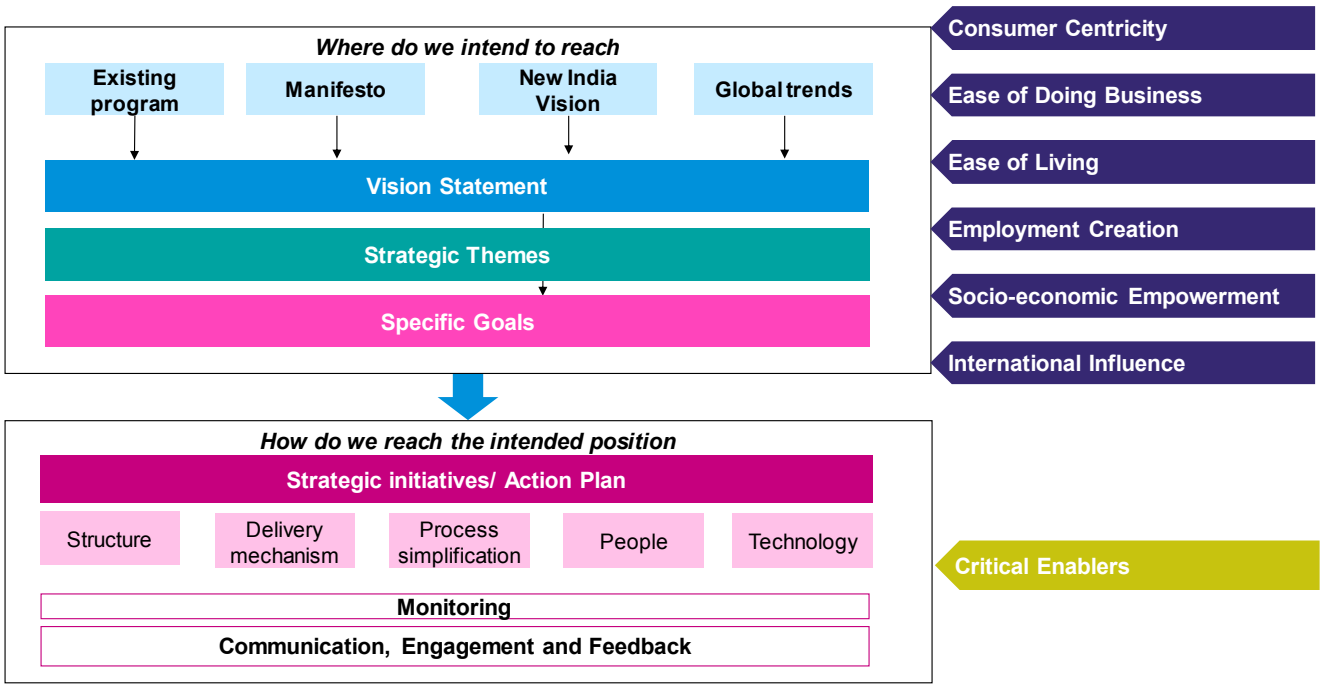
Five Year Vision Document for Power Sector

GOVERNMENT OF INDIA
MINISTRY OF POWER



Five Year Vision Document for Power Sector

Approach for development of 5 year Vision

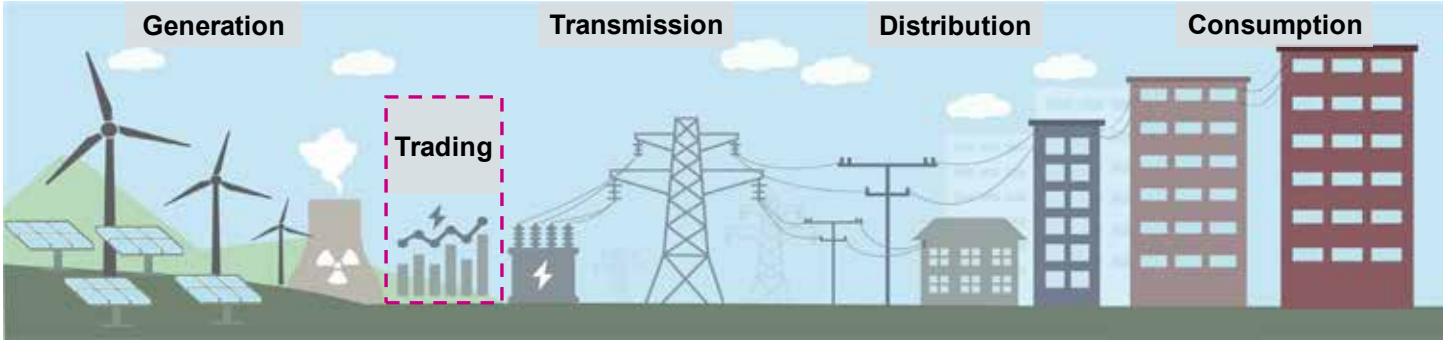


Vision for the Power Sector

A sustainable, viable, efficient and competitive power sector catalyzing economic and social development

3

Overview of the Indian Power Sector



Generation
- Generation De-licensed
- 3rd largest electricity producer in the world
- 5th largest in the world in RE capacity
- Private sector accounts for 46% of the installed capacity

Transmission & Trading
- Transmission and trading both are licensed
- Single largest integrated network in the world
- Private sector accounts for 8% of the network
- Short term market comprises 10% of total energy procured

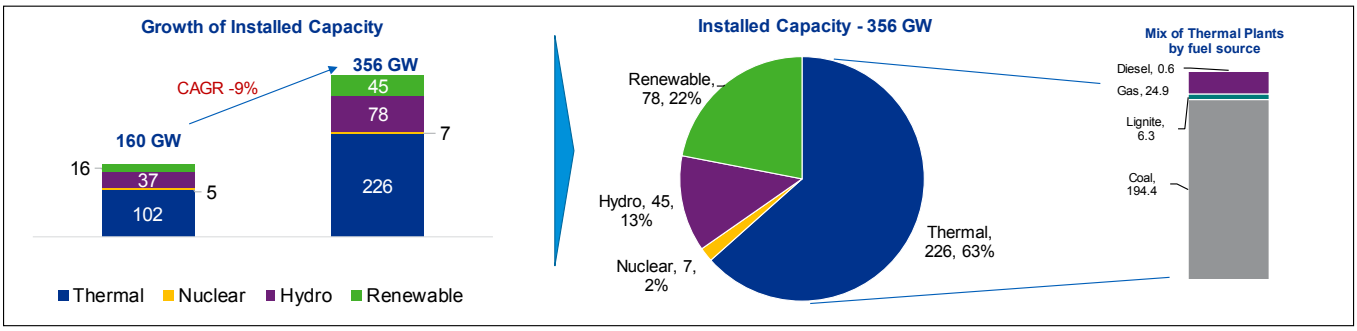
Distribution
- Distribution licensed
- Financial losses of state DISCOMs at ~£1.6 bn (FY'18)
- Persistent AT&C losses
- Distribution and supply business is combined

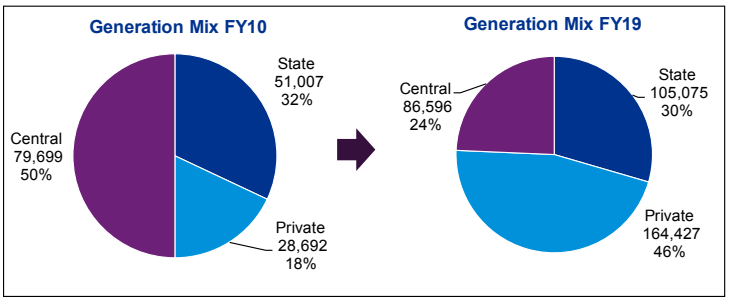
Consumption
- 3rd largest electricity consumer globally
- Per capita consumption is less than 50% of the global average
- Energy deficit decreased from 10% to 0.7% over the last decade

4

Power Generation Sector

The generation capacity has more than doubled since 2010 with an increased participation from the private sector





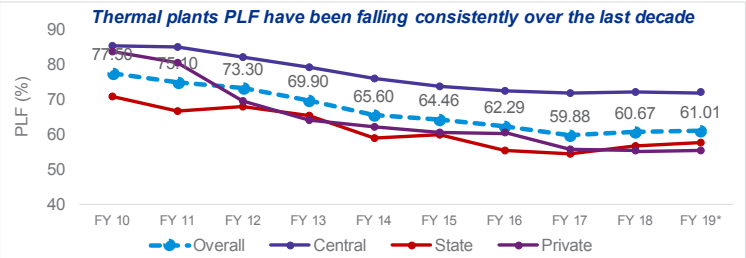
- India ranks **5th** in terms of installed power generation capacity in the world
- The growth has been fueled by large private investment in generation from 29 GW in FY10 to **164 GW** in FY19
- Electricity consumption per capita is at **1149 kWh**, which is less than 50% of global average
- Total GHG emissions* from electricity production is **2,234 MtCo2**

* As on 2017

5

Key challenges faced by the power generation sector

Although the generation capacity has increased in the last decade with significant growth in thermal and solar capacity, the sector is grappling with issues of falling PLF and stressed assets



NPA's in the sector is a concern adversely affecting future avenues for financing

24,405 MW
Commissioned capacity

34 No. of Stressed thermal Projects
40,130 MW

8
projects resolved of capacity 8,820 MW

18,516 MW
PPA Tied up

1.74 lakh Cr
Total Outstanding Debt

Key Issues faced by GENCOs

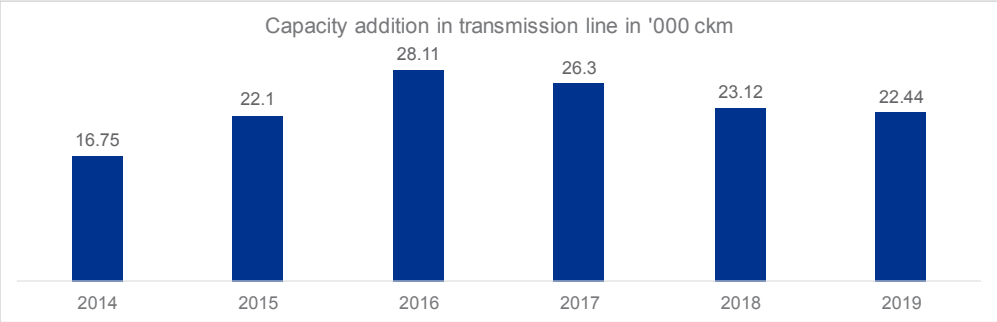
- Unpaid Bills
- Fuel availability for coal and gas powered plants
- Contracts for power sale
- Lack of deep markets
- Lack of finance

6

Power Transmission Sector

The Power Transmission sector acts a pivotal role in supplying electricity to the end consumers

2418 Ckm/ GW of peak demand as on March 2019



Factors driving the growth in transmission capacity

- Increase in demand at Distribution level
- Advent of green corridors
- Allocation via competitive bidding
- Policy support to private player

7

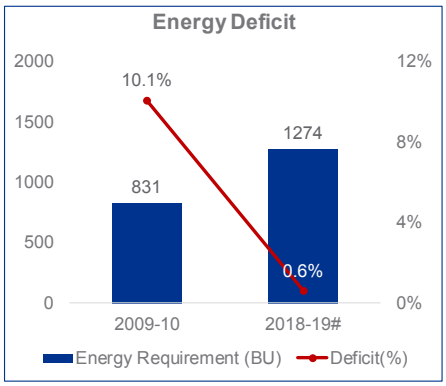
Key challenges faced by Power Transmission Sector

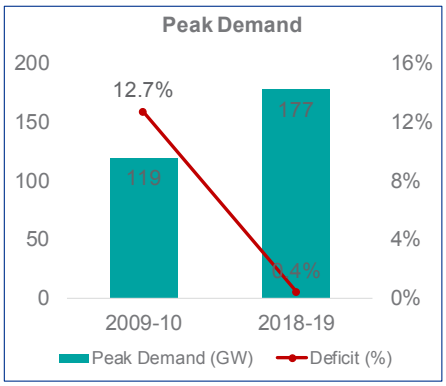
1. The capacity addition for transmission infrastructure needs to aligned with the growth in RE projects
2. The transmission planning needs to be done 1-2 years ahead as the gestation period is less for RE projects as compared to transmission projects
3. Construction time is long because of outdated technologies
4. Allocation of transmission cost for solar and wind needs to be aligned to avoid overcharging the market participants

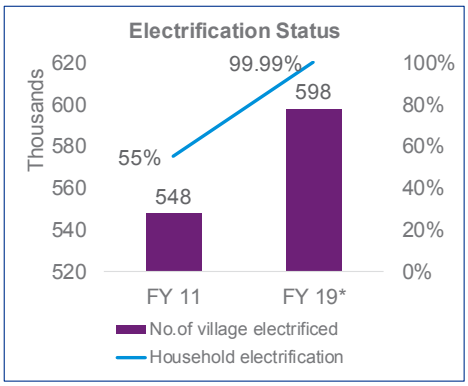
8

Power Distribution Sector

Indian's Power supply position has improved significantly in the last decade and is well on its way to achieve universal energy access





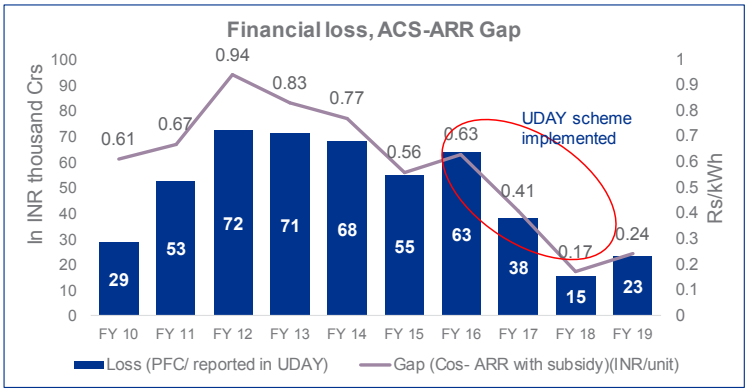


Driven by

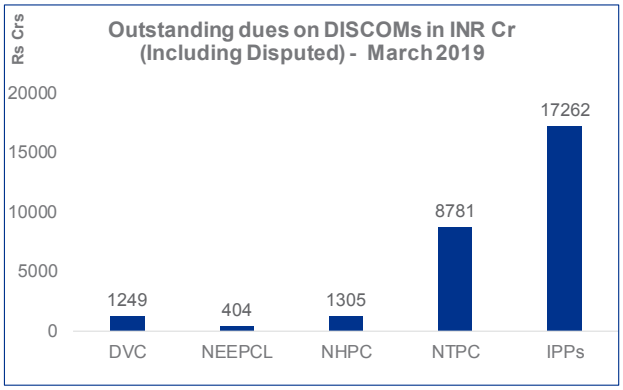
- ***Rural Electrification programs*** - Deendayal Upadhyaya Gram Jyoti Yojana (DDUGVY , Saubhagya)
- ***Improvement in network infrastructure*** - Integrated Power Development Scheme (IPDS)
- ***DISCOMS revival*** - Ujwal DISCOM Assurance Yojana (UDAY), FRP I

9

Key challenges faced by the power distribution sector



Source: PFC reports, UDAY portal



March 2019, Source: PRAAPTI

- **Accumulated losses** of DISCOM have cast a doubt on the their financial viability going forward
- Increase in cost of power to meet the emission requirements ~18-38 paise/unit
- Tariff hike not sustainable - past increases limit headroom
- Operational improvements possible however structural solutions will also be needed to ensure benefits are sustained in the long run

- The high payables are due to
  - **Under Recovery** of cost through tariff's
  - **Non-payment of dues** by Government agencies
- Total Payable days on average are at 90 days
- For some states and generators it has reached 9 months
- Payable are especially high for **IPP's which might result in increase of NPA's**

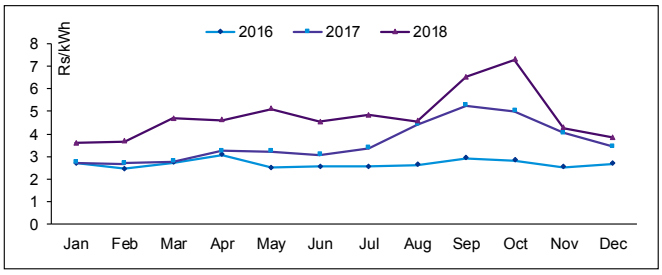
10

Power Market

Current power market structure

Tenure		Contract type	Market Share
Long Term 7 - 25 Years	Medium Term 1 - 7 years	Power purchase agreement with Discom	88.3%
Short Term Less than 1 year		Bilateral trade	5.6%
Less than 2 weeks 1. Intra -day 2. Day Ahead Market 3. Week Ahead Market 4. Term ahead market		Exchange (IEX/PXIL) IEX – Indian Energy Exchange PXIL – Power Exchange of India Limited	4%
Balancing Market Real Time		Unscheduled Interchange (UI)	2%

Monthly trend – Movement of avg. peak prices on IEX (spot prices)



- Most long term PPAs are physical contracts, self scheduled by States or Discoms on a Day Ahead basis
- Remaining ~10% procurement is through Bilateral Contracts and Power Exchanges. Share of Day Ahead Contingency market is almost negligible
- Intra-day energy requirement and imbalances are generally managed through DSM and ASM
- Power Exchanges (PX) also operate Intra day energy market based on continuous trade but liquidity is very low
- Much of the Real Time energy imbalances are managed by revision of schedule (4 time blocks) before the actual dispatch
- Both Generators and Discoms can revise schedule without any financial liability for such revision

Lack of products and liquidity in short term markets leading to high electricity prices despite the supply surplus in the country

11

Key challenges faced by the Indian Power Market

1
- Power demand will continue to grow in the foreseeable future. Supply will struggle to keep pace;
- New build of thermal will taper off, RE will increase and temporal mismatches may cause reliability issues

2
- Siting and location of new generation and transmission capacity will present formidable planning and execution challenges

3
- In an uncertain environment (and also in the context of "perceived surpluses" at present, DISCOMs will continue to contract sporadically and inefficiently

4
- Present contracting/market mechanisms are not signaling to new capacity creation and the appropriate kind of capacity

5
- Fuel allocations mechanisms that favour public sector and long term contracts over markets are impairing capacity utilisation as well as market dynamics

6
- Transmission sector development, corridor allocation and system operating principles are not conducive for deepening of power markets

12

Strategic Themes aligning to the Power Sector Vision

- Sustainable
- Viable
- Efficient
- Technology
- Competitive
- Cultural Transformation

13

Goals

Generation Sector

01	Reduce GHG emission from generation assets to acceptable norms
02	Fully monetize waste streams from conventional generation
03	Modernize generation to enhance asset flexibility and performance
04	Fuel security for coal and gas based power plants
05	Reduce net water use radically in thermal power plants
06	Address non-performing asset challenges

14

Goals

Transmission Sector

01	Improve transmission capacity utilization
02	Modernize transmission infrastructure for robustness and capacity enhancement
03	Reduce state level congestion
04	Facilitate scaling up of renewable energy and reduce/eliminate curtailment
05	Enhance cross border links and trading capabilities

15

Goals

Distribution Sector

01	Improve financial viability & sustainability of DISCOMs
02	Reduce T&D losses to normative or better
03	Introduce competition in retail supply business
04	Enhance end use efficiency and promote efficient consumption
05	Empower users through customer centric new age technologies and applications
06	Improve reliability of distribution network
07	Induct renewable energy and demand side management at scale in distribution system

16

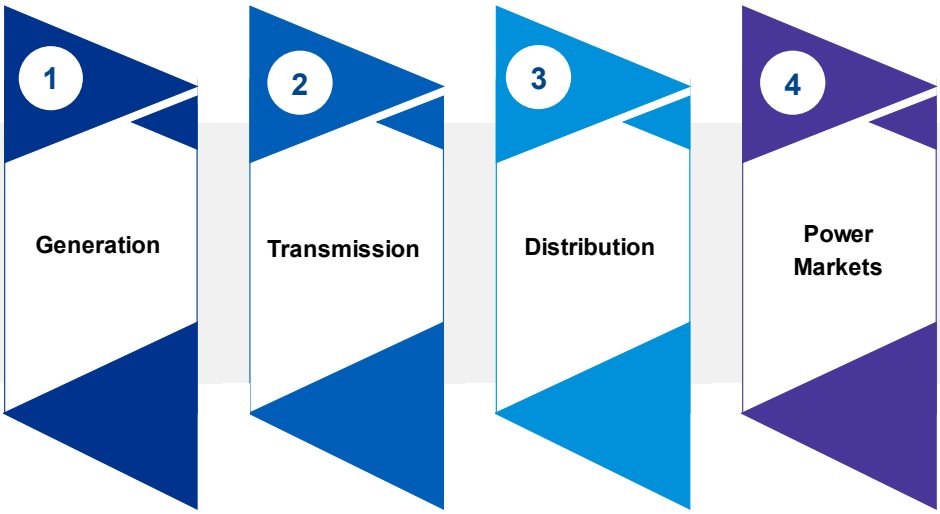
Goals

Power Markets

01	Enhance share of market traded electricity
02	Make markets efficient and transparent
03	Deepen products in market to enhance clean energy
04	Enhance cross border trade through market products

17

Action Plan Framework for achieving the Goals



18

Action Plan Framework

Generation Sector

Goal 01	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Reduce GHG emission from generation assets to acceptable norms	Ensure adherence to environment norms through implementation FGD, NoX etc by 2022	T_0 + 3 years	Indicator – No of power plants retrofitted
	Ensure a fair share of renewable energy sources in the overall installed capacity mix	T_0 + 5 years	% of Energy met through RE resource
	Increase usage of washed coal	T_0 + 5 years	%age share of washed coal
	Explore financial viability of using carbon capture and storage - One demonstration plant to test technical viability	T_0 + 2 years	2 commissioned power plants with the demonstrated technology

19

Action Plan Framework

Generation Sector

Goal 02	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Fully monetize waste streams from conventional generation	Develop policy to enable tie ups of power plant with local entrepreneurs to develop flyash brick/ cement manufacturing units near the power plant	T_0 + 2 years	%age of fly ash utilized
	Invest in R&D to explore new streams of monetizing other waste products	T_0 + 5 years	

WIP

20

Action Plan Framework

Generation Sector

Goal 03	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Modernize generation to enhance asset flexibility and performance	Improve operational efficiency of existing power plants, retire ageing, inefficient power plants	T_0 + 2 years	No.of coal linkage swapped
	Development of AUSC technology and setting up of technology demonstration plant	T_0 + 4 years	No of plant commissioned
	Implement flexibilization measure to enable large scale integration of renewables into the grid • Minimum technical limits to be brought to 55% across generation fleet • Ramp rates to be increased to 2%/min across coal fleet	T_0 + 5 years	No. of plants able to meet technical requirement

21

Action Plan Framework

Generation Sector

Goal 04	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Increase fuel availability at power plants	Enabling tie up with local agri producers for supply of agri-residue/ biomass pellets for co-firing	T_0 + 3 years	5% of country's thermal power from co-firing of biomass pellets
	Co-ordinated planning with Railways to ensure availability of rakes for coal transport	T_0 + 1 years	%age reduction in delay of coal transport
	Enhanced output from Coal India	T_0 + 3 years	Coal Output

22

Action Plan Framework

Generation Sector

Goal 05	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Reduce net water use radically in thermal power plants	Explore options of using technologies having potential to reduce the water consumption in power plants, for eg. Air cooled condensers, techniques to reduce makeup water etc	T_0 + 3 years	Specific water requirement per unit of power generated (cu.m/ kWh)
	Implementation of water harvesting with in power plant and township	T_0 + 2 years	No of power plants with water harvesting options
	Recycle water from STP plants of power units and identify uses	T_0 + 2 years	Gross water requirement of power plant
	Implement monitoring framework to regularly track make up water and ensure it is below 1%	T_0 + 2 years	Make up water requirement

23

Action Plan Framework

Generation Sector

Goal 06	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Address non-performing asset challenges	Initiate bankruptcy/insolvency proceeding for NPA's	T_0 + 2 year	No. of assets resolved
	Revisiting contractual clauses of existing PPAs and structuring new PPAs	T_0 + 2 years	XX
	Develop and implement transparent mechanism for allocating coal linkages to plant with no FSA's	T_0 + 2 years	No. of new coal linkages allocated
	Identify avenues to ensure affordable supply of gas to Gas based power plants	T_0 + 2 years	PLF of gas based power plants
	Improve payment security mechanism for power plants to mitigate delayed payments by DISCOMS	T_0 + 3 years	Reduction in payables in INR Cr

24

KPI Matrix

Generation Sector

S. No	KPI	Current	Year 1	2 year 2	Year 3	Year 4	Year 5
1	No of power plants retrofitted						
2	% of Energy met through RE resource						
3	%age share of washed coal						
4	%age of fly ash utilized						
5	Reduction in SHR						
6	5% of country's thermal power from co-firing of biomass pellets						
7	PLF of gas based power plants						
8	Specific water requirement per unit of power generated (cu.m/ kWh)						
9	Reduction in payables in INR Cr						
10	No of stressed assets resolved						

25

Action Plan Framework

Transmission Sector

Goal 01	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Improve transmission capacity utilization	Remove critical bottlenecks • Study assess bottlenecks and identify remedial actions • Introduce policy framework for accelerated removal	T_0 + 1 year	Policy document on remedial actions
	Improve transmission planning framework • Adopt integrated transmission planning approaches incorporating conventional and RE generation and dynamic load characteristics • Annually update the transmission plans and publish	T_0 + 2 years	Planning document on capacity addition
	Rationalise transmission pricing • Rationalise slabs and rate framework in Point of Connection (PoC) charges mechanism	T_0 + 1 years	Revised PoC determination methodology
	Introduce transmission capacity trading • Physical capacity trading • Financial Transmission Rights (FTR) trading over a period of time	T_0 + 2 years	XX

26

Action Plan Framework

Transmission Sector

Goal 02	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Modernize transmission infrastructure for robustness and capacity enhancement	Induct Flexible AC Transmission Systems (FACTS) and other new age technologies at scale	T_0 + 3 years	Investment in transmission sector
	Improve asset monitoring mechanisms	T_0 + 1 year	XX

27

Action Plan Framework

Transmission Sector

Goal 03	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Reduce state level congestion	Enhance private sector participation in hotspot states • New build through Tariff Based Competitive Bidding (TBCB) • Reconductoring old lines with new age technology to improve capacity and reliability	XX	XX
	Improve capabilities in SLDCs • Enhancing operations protocols – implementation of SAMAST • SLDC infrastructure and its integration with overall grid management infrastructure • Human capabilities in SLDC through certification	XX	XX
	Enhance capabilities in the state utilities, SLDC and other relevant entities • forecasting and scheduling capabilities • Overall digital capabilities to ensure real time response in contingency situations - automation enabled and backed by human supervision capabilities	XX	XX

28

Action Plan Framework

Transmission Sector

Goal 04	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Facilitate scaling up of renewable energy and reduce/eliminate curtailment	Build new transmission infrastructure in renewable heavy areas to prevent curtailment and promote renewable energy build • Green corridors • Last mile connectivity • Assess transmission level storage	XX	XX
	Introduce rational transmission pricing mechanisms for renewables • As RE capacity increases migrate from free ISTS regime to rational charges (without over-burdening) • Pay for curtailment (beyond agreed thresholds)	XX	XX
	Induct modern technology for RE management • Enhance transmission and distribution coordination for RE (given that a lot of new RE will be at distribution levels) • Strengthen REMCs to have integrated view of system along with TSO and DSO • Evolve principles/ plan for storage installation and management	XX	XX

29

Action Plan Framework

Transmission Sector

Goal 05	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Facilitate enhancement of cross border energy trade	Deepen physical interconnections with BBIN	XX	• No.of transmission corridors/package identified • No of bids conducted
	Harmonize regulations and enhance operating protocols for effective and smooth operations	XX	XX

30

KPI Matrix

Transmission Sector

S. No	KPI	Current	Year 1	2 year 2	Year 3	Year 4	Year 5
1	MVA of inter-state capacity added						
2	%Volume of electricity that could not be cleared as % to Unconstrained Cleared Volume						
3	Percentage of the time congestion occurred during the month (Number of hours congestion occurred/Total number of hours in the month)						
4	No. of transmission corridors/package identified						
5	No of bids conducted						

31

Action Plan Framework

Distribution Sector

Goal 01	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Improve financial viability & sustainability of DISCOMs	• Implementation of analytical tools for PP (power purchase) cost optimization	T_o + 1 year	%age reduction of PP cost
	• Implement prepaid metering for high risk consumers to improve collection efficiency • Encourage digital payments and send reminders on a regular basis to improve ease and ensure timely payments	T_o + 2 years	Collection Efficiency
	• Strengthen ERC's and improve monitoring framework to ensure true cost recovery for DISCOMs	T_o + 2 years	• Tariff order filed on time • True-ups filed on time and approved • Reduction in regulatory assets
	• Develop payment security mechanism to ensure timely payments from government entities	T_o + 2 years	• Payment pending from Government agencies in INR Cr

32

Action Plan Framework

Distribution Sector

Goal 02	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Reduce T&D losses to normative or better	• Increase transparency in T&D losses through implementation of IoT/smart metering and energy audits to enable accurate measurement	T_o + 3 years	• % Coverage of Feeders under energy audit
	• Network modernization and capacity expansion to mitigate high load areas	T_o + 2 years	• Increase in distribution capacity (5% increase in every year from the existing capacity)
	• Increase use of energy efficient 5 star rated equipment in distribution expansion/ replacement	T_o + 3 years	• Usage of 5 star rated DTR/PTR
	• Ensure 100% metering for all categories of consumers	T_o + 2 years	• %age of metered connections

33

Action Plan Framework

Distribution Sector

Goal 03	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Introduce competition in retail supply business	Develop mechanism for unbundling distribution companies into wires and supply business	XX	XX
	XX	XX	XX
	XX	XX	XX

WIP

34

Action Plan Framework

Distribution Sector

Goal 04	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Enhance end use efficiency and promote efficient consumption	Implementation of energy efficient grid connected solar pumpsets in agriculture integrated with net metering	T_o + 3 years	KPI related to KUSUM scheme
	Utility driven adoption of energy efficient appliances for water heating and air conditioners similar to LED bulbs and fans	T_o + 5 years	Number of inefficient ACs and Water Heaters replaced

35

Action Plan Framework

Distribution Sector

Goal 05	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Empower users through customer centric new age technologies and applications	Digital smart grid for consumers showing the usage patterns, tips for conserving energy, etc.	T_o + 4 years	XX
	Proactive notifications to consumers through SMS email mobile apps on outages, status of complaints	T_o + 1 year	XX
	One stop shop app - Comprehensive mobile applications covering all consumer touchpoints with DISCOMs (for payments, complaints, new applications, etc.)	T_o + 1 year	Time taken to develop the app Number of downloads from playstore
	Advanced IVRS and Customer Care	T_o + 2 years	XX
	2 Way SMS Service for key consumer services	T_o + 1 year	XX

36

Action Plan Framework

Distribution Sector

Goal 06	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Improve reliability of distribution network	Improved reliability with implementation of SCADA/DMS & ADMS for cities, towns, industrial areas in Phase – 1 To be expanded to rural areas in Phase – II	T_o + 2 years	XX
	Implement real time feeder monitoring for all feeders using IoT to identify outages and improve response time	T_o + 3 years	Reduction in feeder outages

37

Action Plan Framework

Distribution Sector

Goal 07	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Induct renewable energy and demand side management at scale in distribution system	Develop viable business models to enable increased adoption of Solar rooftop projects (SRT) by domestic category	T_o + 3 years	Capacity of SRT added by domestic consumers
	Enable ease of access to affordable financing	T_o + 2 years	No. of financial instruments developed for SRTs
	Implementation of Geo tagging and real time monitoring of generation from distribution level generation sources, especially solar rooftop projects	T_o + 3 years	XX
	Implementation of demand response techniques to help manage peak load	T_o + 2 years	XX
	Develop adequate EV adequate charging infrastructure	T_o + 2 years	No. of charging infrastructure constructed

38

KPI Matrix

Distribution Sector

S. No	KPI	Current	Year 1	2 year 2	Year 3	Year 4	Year 5
1	%age reduction of PP cost						
2	Collection Efficiency						
3	Payment pending from Government agencies in INR Cr						
4	% Coverage of Feeders under energy audit						
5	%age of metered connections						
6	Number of inefficient ACs and Water Heaters replaced						
7	Capacity of SRT added by domestic consumers						
8	No. of financial instruments developed for SRTs						

39

Action Plan Framework

Power Markets

Goal 01	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Enhance share of market traded electricity	**Improving the liquidity short term (ST) by enabling increased participation of Discoms and Gencos-** • Stronger regulations and stringent penalties for discouraging use of DSM to meet energy requirement • Review of gate closure norms and 'Right to Recall' • Allowing state and central Gencos to sell surplus power **Alternative mechanisms to flexibilise existing long term contracts** - Long Term PPAs can act as forward contracts, while physical transactions can take place ST Market. Financial products such as Contracts for Differences (CfD) can be enablers.	Short- Medium term	XX
	Introduction of Real Time Market (basis CERC's discussion paper) • To help improve market liquidity	Medium term	XX
	Move to shorter term and more flexible PPAs	Long term	XX

40

Action Plan Framework

Power Markets

Goal 02	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Make markets efficient and transparent	**Strengthening of data disclosure regime -** • Regulations to mandate disclosure scope and set accountability • Standardisation of data disclosure **Better demand forecasting and power procurement optimization approaches** **Move towards a "new form of market" based on Centralised Despatch with CfD's – least cost provision of power**	Short- medium term	XX
	Robust planning regime at national and state level • Multiple scenarios based approach for energy system development in near to long term • Plans to send clear market signals for capacity addition **Resource adequacy (capacity) mechanisms** • Revive the long term capacity investments (beyond RE) • Dedicated auction platforms (like DEEP) for long term contracting **Introduce financial products such as derivatives for hedging risks and improving liquidity.**	Medium- Long term	XX

41

Action Plan Framework

Power Markets

Goal 03	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Deepen products in markets to enhance clean energy	**Introduction of Real Time Market (RTM) for improved reliability and control and better absorption of RE** • Aim is to manage the differences in day ahead forecasts and actual conditions closer to real time • This becomes critical in view of increasing RE share.	Short to Medium term	XX
	Move from regulated to market based mechanism for Ancillary Services • Introduce new technologies such as battery storage to respond quickly (primary response) to grid fluctuations • Introduce innovative models such as Demand Response • Will help signal new investments (storage, flexible thermal etc.)	Medium to Long term	XX
	Inclusion and scale up of innovative models for Dencentralised Renewable Energy (DRE) based access • Utility driven models for solar rooftop installation • Other products and services for cooking, heating, lighting etc.	Short-Medium term	XX

42

Action Plan Framework

Power Markets

Goal 04	Implementation Roadmap		
Goal	**Potential Interventions/ Actions**	**Timeline**	**Key Performance Indicators**
Enhance cross border trade through market products	• Introduce standardized products in Day-Ahead Markets, Intra-day, Term-Ahead market for cross-border electricity trading – physical delivery • Introduce products in Balancing market for trading of balancing services from fast response plants such as Hydro • Introduction of financial products – futures and derivatives	Medium to Long term	XX

43

KPI Matrix

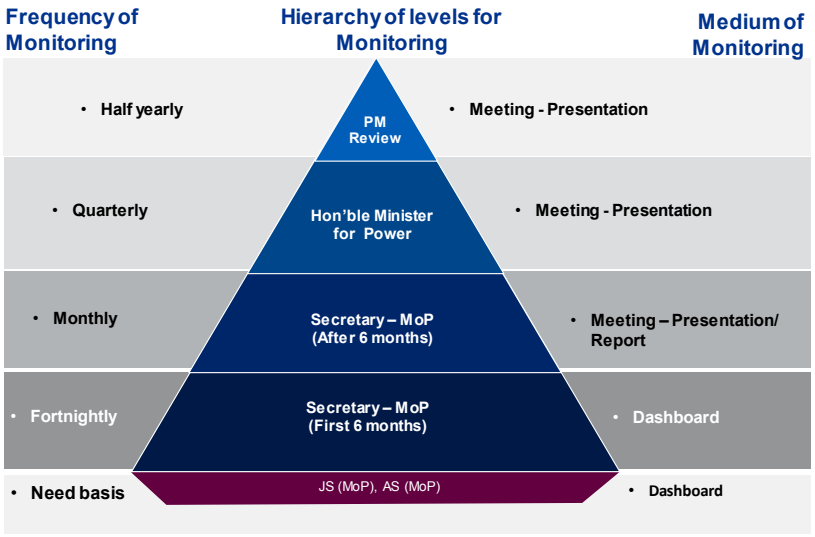
Power Markets

S. No	KPI	Current	Year 1	2 year 2	Year 3	Year 4	Year 5
1							
2							
3							
4							
5							
6							
7							
8							

WIP

44

Monitoring mechanism



Communication Framework

Medium	Frequency	Key Content
Print Media	Fortnightly	Achievements with statistics
TV Media	Periodic	Beneficiary stories
Radio	Periodic	Beneficiary stories
Twitter	Daily	PSU Events/ Statistics
Facebook	Daily	Achievement Videos
Watsapp	Daily	Achievements with statistics

45

Critical Enablers

Policy Interventions

- Cost recovery mechanism for investment especially on emission reduction , Flexibilization of power plants
- Framework and regulations for separation of carrier and content
- Mechanisms to pass cost escalation in supply chain to retail tariffs with minimal interventions
- Ratify amendments to the Electricity Act 2003
- Fuel market opening up

Stakeholder buy-in

- State's commitment to implement reform measures especially on metering agricultural consumption and introducing competition in retail supply business
- Financial support for investments in network modernization, smart grid implementation
- Improve co-ordination between State/Central agencies in capacity planning across G-T-D

Institutional Strengthening

- Capacity building of staff on new age technologies
- Increased independence of regulators
- Creation of AMC to clean-up bad debts/losses of distribution companies
- Payment security mechanism/risk sharing models for sustained investments from private sector – GoI/state government backed bonds for loss reduction

46

Summary

1. Electrification of economy a global trend: Focus of vision on sector modernization
2. Sustainability a key ask: Measures proposed reflect sustainability goals
3. Financial viability restoration across value chain a core focus
4. Market transformation a key means to achieve sector goals: Roadmap included in vision
5. Technology and digital transformation a core focus of the vision: to be tracked closely

47

INDIA ENERGY FORUM

ISSUES IN HYDROPOWER

Shri Jayant Kawale
Former JS (Hydro), MoP, Government of India

ISSUES IN HYDROPOWER

Shri Jayant Kawale

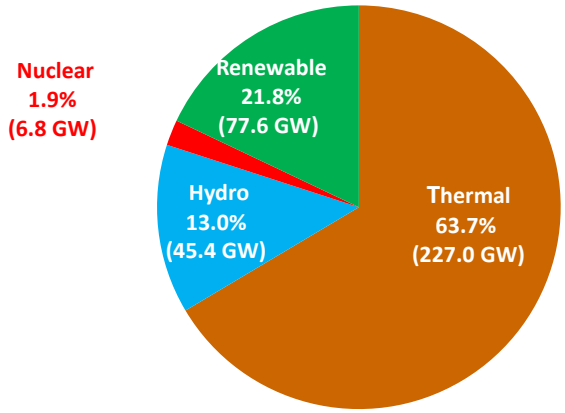
Former JS (Hydro), MoP, Government of India

POWER SCENARIO IN THE COUNTRY

Sector–wise Installed Capacity & Energy Generation

INSTALLED CAPACITY (MW)

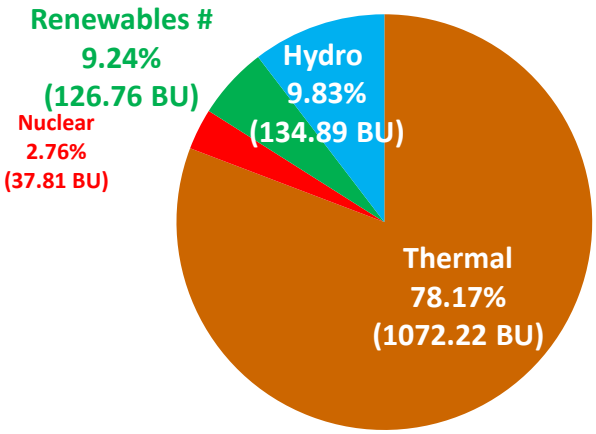
(As on 30.04.2019)



Total : 356 GW

ENERGY GENERATION (BU)

2018-19



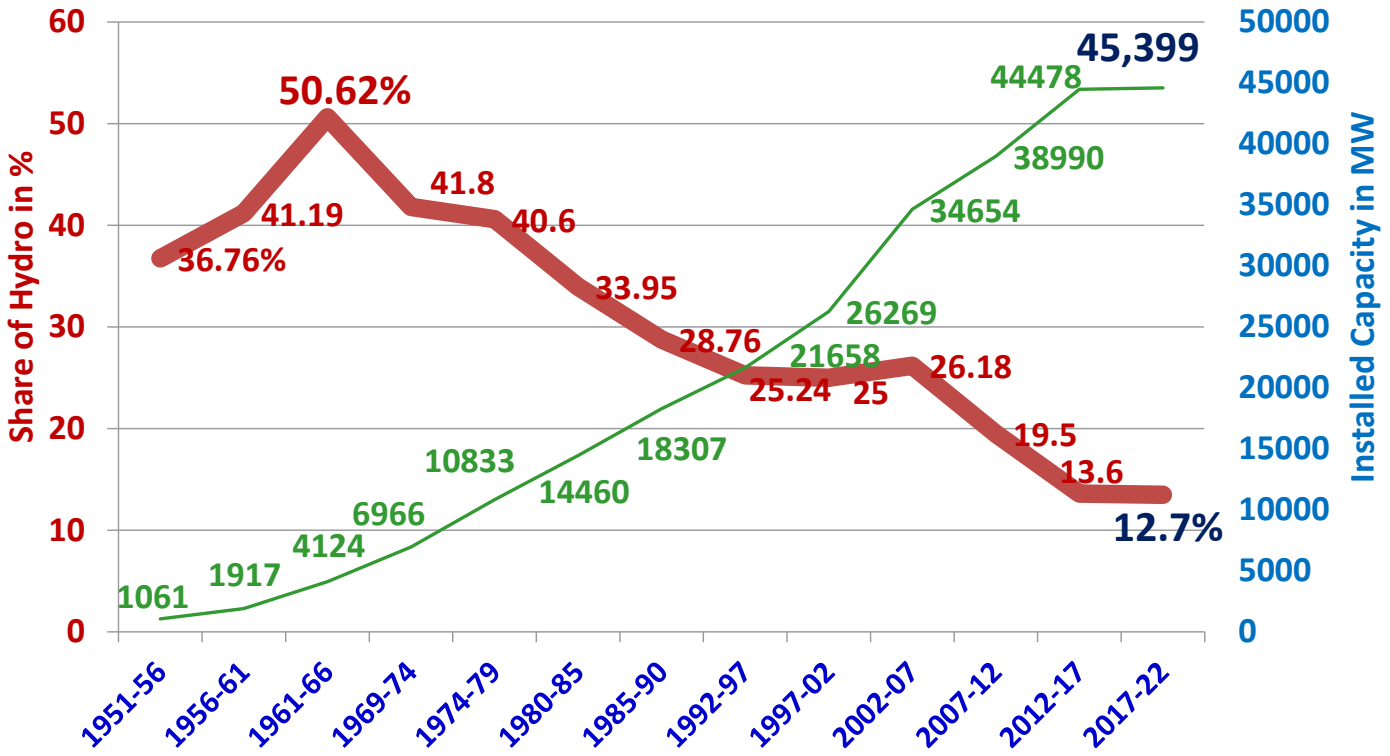
Total : 1371.68 BU*

*(Excluding 4.43 BU imports from Bhutan)

JOURNEY OF HYDROPOWER DEVELOPMENT

Increasing Capacity & Declining Share

As on 31.05.2019



Cabinet Approval dated 7th March 2019

Measures to promote Hydro Power Sector

(Circulated vide Ministry of Power Office Memorandum F. No. 15/2/2016-H-I (Pt); dated 8 March' 2019)

Declaring LHPs (> 25 MW projects) as Renewable Energy source

- Large Hydropower Projects (LHPs, i.e., > 25 MW projects) are declared as Renewable Energy source.
- However, LHPs would not automatically be eligible for any differential treatment for statutory clearances such as Forest Clearance, Environmental Clearance, NBWL Clearance, related Cumulative Impact Assessment & Carrying Capacity study, etc., available to Small Hydropower Projects (SHPs), i.e., projects of capacity up-to 25 MW.

- Ministry of Power shall continue to be the Administrative Ministry for LHPs.

Hydro Purchase Obligation (HPO) as a separate entity within Non-Solar Renewable Purchase Obligation (RPO)

- Hydropower Purchase Obligation (HPO) is notified as a separate entity within Non-Solar Renewable Purchase Obligation (RPO).
- The HPO shall cover all LHPs commissioned after issue of this Office Memorandum as well as the untied capacity (i.e., without PPA) of the commissioned projects.
- This HPO will be within the existing Non-Solar RPO after increasing the percentage assigned for it so that existing Non-Solar RPO for other renewable sources remains unaffected by the introduction of HPO.
- The trajectory of annual HPO targets will be notified by Ministry of Power based on the projected capacity addition plans in hydropower sector.
- Necessary amendments will be introduced in the Tariff Policy and Tariff Regulations to operationalize HPO.

Tariff rationalization measures for bringing down hydropower tariff

- Tariff rationalization measures including providing flexibility to the developers to determine tariff by back loading of tariff after increasing project life to 40 years, increasing debt repayment period to 18 years and introducing escalating tariff or EMI or both depending upon loan repayment plan , cash flows or DSCR etc.
- The levellized tariff over the useful life of the project may be calculated on the basis of the norms specified in the CERC regulations and thereafter, the determination of year wise tariff, for a long term PPA for procurement of hydro power for a period of not less than specified years (depending upon the repayment plan for the debt raised by the generator such that major part of the loan is repaid during the tenure of such PPA), may be left to the Developer and DISCOMs as per their feasibility and depending upon the terms of repayment of loan negotiated with the lenders subject to;
    - submission of such complete calculations with assumptions to be provided by the generator of hydro power at the time of filing of the application; and
    - upfront approval by the appropriate Regulatory Commission.

Budgetary Support for Flood Moderation / Storage Hydro Electric Projects (HEPs)

- In-principle approval is accorded for providing budgetary support through the budgetary grant of Ministry of Power for Flood Moderation component for Storage HEPs to be set up in future.
- The value of flood moderation component will be worked by technical agencies, viz, CWC, etc. in accordance with the guidelines.
- The amount required for flood moderation / storage costs shall be released through MoP budgetary provisions after appraisal of each project, on a case to case basis, by Public Investment Board (PIB) / Cabinet Committee on Economic Affairs (CCEA) as per due process.
- This shall be applicable to both Government as well as Private Hydropower Projects having Flood Moderation Component

Budgetary Support to Cost of Enabling Infrastructure, i.e., roads/bridges

- In-principle approval is accorded for providing budgetary support through the budgetary grant of Ministry of Power for funding enabling infrastructure for hydropower projects (Government & Private) primarily Roads and Bridges.
- This support shall be applicable for projects starting construction after notification of this Office Memorandum.
- This budgetary support would be provided after appraisal / approval of each project by PIB / CCEA as per the extant rules / due process.
- The limit of this grant for such roads and bridges would be as follows –
    - Rs. 1.5 Crore per MW for projects up to 200 MW
    - Rs. 1.0 Crore per MW for projects above 200 MW

What ailed hydropower?

- Uncertain and interminable approval process
  - constantly changing EIA requirements
  - land acquisition and resettlement issues
  - local opposition due to various reasons
- Difficulties in project implementation
  - inability of PSUs in dealing with contractual issues and with geological surprises
  - inexperience of private developers
  - limited number of competent contractors
  - court/govt interventions instigated by NGOs

What ailed hydropower

Uncompetitive tariff/ project returns
- upfront payment, free power
- burden of developing infrastructure- very high IDC due to long project cycles
- mismatch of project life with repayment period and with PPA
- transmission
- value as peaking power not realized – TOD tariffs, ancillary services

What ailed hydropower?

- Unwillingness of Discoms to sign PPAs

- uncertain tariff- uncertain project schedule
- abundantly available cheaper power from thermal and now solar
- 24/7 power is not a serious goal for Discoms or for regulators

- Vanishing appetite on the part of lenders for power sector in general

Problem with HPO

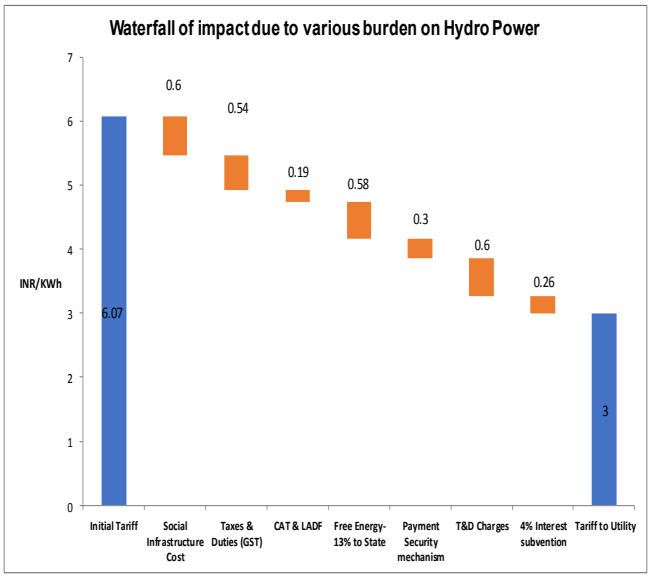
- RPO for wind and solar was justified due to nascent technologySolar dramatically lived up to the expectation of fall in tariff
- HPO will not lead to such fall in tariff
- Cannot be a solution for lack of viability (Gas Purchase Obligation was also proposed!)
- It can at best be a temporary relief measure
- Discoms will eventually resist
- In the long run, Discoms should be made to want hydro for its own intrinsic advantages. How to ensure that? Solar with storage is a serious competitor

ULTIMATELY, SOPS WILL ONLY TAKE YOU SO FAR
HYDROPOWER NEEDS TO BE MADE MORE COMPETITIVE:
REDUCE COSTS/TARIFFPRICE OTHER BENEFITS APPROPRIATELY

What More is required for Viable Hydro

1. All Hydro as Renewable thereby extending all benefits of Small Hydro like financial assistance which MNRE is giving to Small Hydro
2. **HPO s** – should be Long Term Trajectory for HPOs, minimum till 2030 to make them viable.
3. **Long term Financing** up to 20/25 years & priority lending
4. **GST at par** with Renewables and **no water tax or cess**
5. Interstate and Intra state **transmission charges to be same** as RE
6. **Staggering of Free Power** component to State **to make tariff competitive.**

HYDRO FACTUAL POSITION



Particulars	Solar	Hydro
Tariff	2.50	3.00
Social Infra. Cost	0	0.60
Taxes (GST)	0.15(5%)	0.54 (18%)
CAT & LADF	0	0.19 (4.5%)
Free Energy	0	0.58 (13%)
Transmission Charges	0	0.60
Payment Security Mechanism	0	0.30
Interest rate risk	0	0.26
Total Tariff to Utility	**2.65**	**6.07**

Hydro cost is competitive provided treated at Par with renewables. Its long term cheaper and sustainable if lifecycle cost is valued and a country's asset

Hydro is State subject and has licensing which requires handing over back to State free of cost after end of concession period of 30/35/40 years

Life Cycle Is >70 Years with Refurbishment which gives 100% free power to State after 35 years

HYDRO SUFFERS UNFAIR COMPARISON

Some remaining issues

- Subansiri/Dibang
- Inclusion of pumped storage
- GST benefit
- Transmission
- Something is better than absolutely nothing
- Too little, too late
- Devil is in the details
- Proof of the pudding is in its eating

INDIA ENERGY FORUM

Is the New Policy on Hydro Power Adequate for Development?

Prepared by
B Bhambhani, Convenor (Power), IEF
and S C Sharma, Former Director, THDC
and Member, IEF

Is the New Policy on Hydro Power Adequate for Development?

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"**Urja Vichar Manch** " under the aegis of "**India Energy Forum** " organized the discussions on the theme "**Hydro Power –Is the new policy adequate for development** " at PHD House on 28th June 2019. Shri B Bhambhani, Convenor, Power, IEF welcome the Distinguished Speakers and Delegates for deliberation on this topic of national interest. He mentioned that there is an urgent need increase share of hydro in the overall power generation target of India.

Shri Anil Razdan, Former Secretary (Power), GoI, chaired the session. **Shri J S Bawa** , Chief Engineer (HPI), Central Electricity Authority; **Shri Jayant Kawale** , Former Joint Secretary (Hydro), Ministry of Power and **Shri Janardan Chaudhary**, Director(T), NHPC made detailed presentation on the "Measure to promote Hydro Power Sector" circulated vide Ministry of Power OM No. 15 / 2/ 2016 – H- 1(Pt.) dated 8th March 2019. The discussions were focused on the five major decisions approved by the Cabinet Sectt. DO No. 11/CM/2018(iii) dated 7th March 2019

- Declaring Large Hydro Projects (LHPs) > 25 MW as Renewable Energy Source
  - ✓ LHPs would not be eligible for any differential treatment for statutory clearances such as Forest & Environment clearances , NBWL clearance, Cumulative Impact Assessment and carrying capacity study etc. available to small Hydro Projects
- Hydro Purchase Obligation(HPO) notified as separate entity within non Solar Renewable Purchase Obligation(RPO)
  - ✓ HPO shall cover all LHPs commissioned after issue of OM by MoP as well as untied capacity (i.e without PPAs) of the commissioned Projects
  - ✓ HPO will be within the existing Non Solar RPO after increasing the percentage assigned to it so that the existing Non Solar RPO for other RE Sources remains unaffected by the introduction of HPO.
  - ✓ Trajectory of annual HPO targets will be notified by MoP based on the projected capacity addition plan in the Hydro Sector.

- ✓ Necessary amendments shall be introduced in the Tariff Policy and Tariff Regulations to operationalize HPO

- Tariff Rationalization Measures for bringing down Hydro Tariff
  - ✓ Flexibility to the developers to determine Tariff by back loading of Tariff after increasing the Project life to 40 years, increasing debt repayment period to 18 years and introducing escalating Tariff of 2%
  - ✓ The levelized Tariff over the useful life of Project may be calculated as per CERC specified Norms and determination of year wise Tariff to be left to the developers and Discoms as per feasibility and depending on terms of loan repayment
- Budgetary Support for flood moderation / storage HEPs
  - ✓ In principal approval accorded for providing Budgetary support through Budgetary grant of MoP for storage HEPs to be setup in future
  - ✓ The value of flood moderation component will be worked by technical Agencies viz. CWC etc. in accordance with guidelines
  - ✓ Amount required for flood moderation/ storage cost shall be released through MoP budgetary provision after appraisal of each project by Public Investment Board (PIB) / Cabinet Committee on Economic Affairs (CCEA) as per due process
  - ✓ This shall be applicable to both Govt. as well as Private Hydro Projects having flood moderation component.
- Budgetary Support to cost of enabling Infrastructure i.e Roads / Bridges
  - ✓ Applicable for Project starting construction after notification of official memorandum
  - ✓ To be provided after appraisal/ approval of each project by PIB / CCEA
  - ✓ Limits of this grant shall be as follows
    - Rs. 1.5 Cr. Per MW upto 200 MW Projects
    - Rs. 1.0 Cr. Per MW above 200 MW Projects

Discussions / Conclusions

- Sh.J S Bawa , CE/ CEA while presenting overall Power scenario with Hydro Power share of 13 %(as on May 2019) focused on initiatives taken by Ministry of Power, GoI for promoting Hydro Power sectors. He has elaborated on each of the measures and explained the various procedures to be adopted for implementing the decisions. Sh. Bawa presented the positive impact on Tariff analysis of a notional 500 MW project with capital cost of 5000 Cr. having Debt- Equity ratio of 70/ 30 with interest rate of 10%, annual salable energy of 1882 MU and gave comparison of the summary of Tariff analysis with 12 years and 18 years loan tenure. He also gave assessment for trajectory of HPOs based on annual capacity addition programme /projections /untied capacity upto 2026-27. He opined that with the new Hydro Policy measures, Hydro Power will become more competitive and will boost the Renewable Energy in the overall mix of power generation.

- Sh. Jayant Kawale, Former Jt. Secy.(Hydro), MoP while appreciating the measures for promoting Hydro Power explained the procedural limitations for the implementation for the various approval processes. He elaborated on the uncertain and interminable approval process for EIA requirements, Land Acquisition & Resettlements issues, difficulties in project implementation with geological surprises & contractual issues, Courts / Govt. interventions instigated by NGOs. He also expressed concern on unfair comparison of Hydro Tariff which has elements of free power to states, higher GST, Social Infrastructure costs etc. in comparison to Solar as Renewable Power. Further, He opined that there is also vanishing appetite on the part of vendors for power sector in general.

- Sh. Janardan Chaudhary, Director (T) NHPC, presented his views in detail enumerating the positive impact on Hydro Projects of Teesta iv HEP (520 MW) and Debang HEP(2880 MW) for Tariff rationalization and Budgetary support for flood moderation and enabling Infrastructure i.e. Roads/ Bridges. He further expressed that Tariff related issues have been largely addressed with the Tariff rationalization measures and introduction of HPOs . He also opined that the inclusion of LHPs in Renewable Energy, the overall energy mix will also have positive impact and Renewable Energy capacity would increase. This would also immediately help India achieve target of 175 GW by 2022. With HPO as separate entity within Non-Solar RPO, State distribution companies will be obliged to purchase certain percentage of Hydro Power making the power sector competitive.

While elaborating recommendation of the 43rd Report of the standing committee on Energy, he mentioned that although some of the recommendations have been included in the new Hydro Policy, however, there is a need to streamline the process of Environment and Forest clearance , compensatory afforestation , rationalization of impact of water cess and free power to the states.

- Sh. Anil Razdan, former Secy (Power) , GoI and chairman of the session concluded that the recent Cabinet decision of 7th March 2019 on the measure to promote Hydro Power sector is a positive step by Government of India. This will give impetus for the Hydro Power Development as Renewable source of Energy and a peaking & balancing support for intermittent Solar and Wind Energy. He supported the views expressed by various speakers and there is need to streamline procedure of Environment and Forest clearance, Land Acquisition & Rehabilitation issues for accelerating the Hydro Power development. The value of Hydro Power as peaking power must be realized for long term benefits of power sector.

There was large response from the delegate present. The speakers tried their best to answer the question raised by the participants. Shri Bhambhani thanked all the Speakers and delegates for their gracious present.

INDIA ENERGY FORUM

Digital Transformation Trends in Power Sector-Automation

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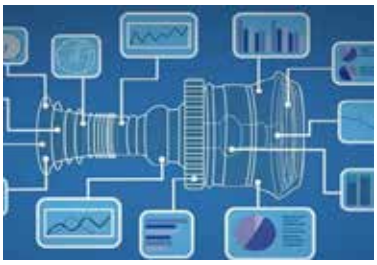
Digital Transformation Trends in Power Sector-Automation

S. K. DUTTA
HOD – C&I (Engineering), NTPC Ltd



Contents

- Power Sector Scenario / NTPC Limited - Portfolio and Commitments
- Automation in NTPC Power Stations
- Digital Transformation Imperative, Focus area and Pillars
- Digital Transformation in NTPC – Major Ongoing Initiatives
- Challenges and Learnings

Indian Power Sector

Power Generation: India

India Capacity (March 2019)	MW	% of Total
Coal/Lignite	2,00,644	56
Gas	24,937	7
Oil	637	0.2
Total Thermal	2,26,218	64
Nuclear	6,780	2
Hydro	45,399	12
Renewable	77,641	22
Total (MW)	3,56,038	100

April 2018 to Mar 2019		
Type	Generation (BU)	(%)
Thermal	1072	78
Nuclear	37	2
Hydro	135	10
Renewable	127	10
Total	1,377 BU	100

NTPC: 55 GW (16%)

NTPC: 306 BU (23%)

Per Capita: 1181 KWhr

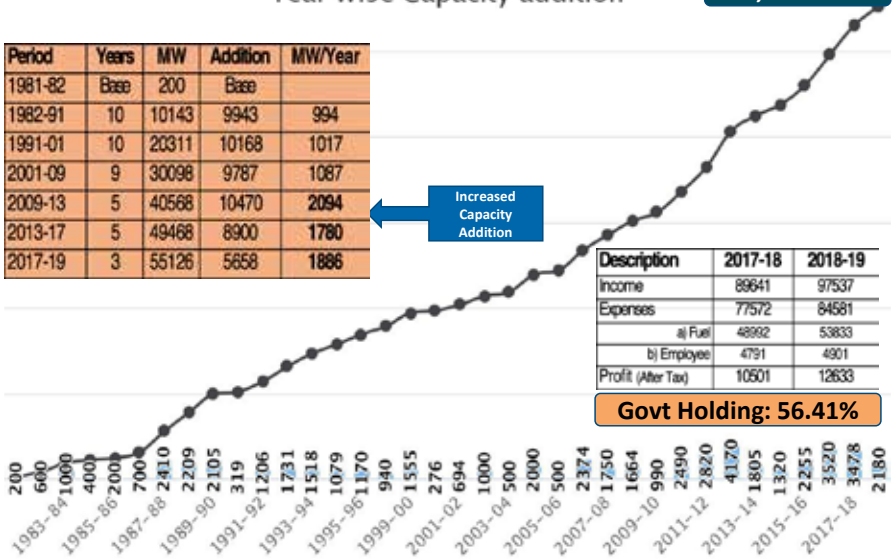
Project Execution: *NTPC*

Year Wise Capacity addition

55,786 MW

Period	Years	MW	Addition	MW/Year
1981-82	Base	200	Base	
1982-91	10	10143	9943	994
1991-01	10	20311	10168	1017
2001-09	9	30098	9787	1087
2009-13	5	40568	10470	2094
2013-17	5	49468	8900	1780
2017-19	3	55126	5658	1886

Increased Capacity Addition



Description	2017-18	2018-19
Income	89641	97537
Expenses	77572	84581
a) Fuel	48992	53833
b) Employee	4791	4901
Profit (After Tax)	10501	12633

Govt Holding: 56.41%

Type	MW	%
Coal	48074	86
Gas	5984	11
Hydro	800	1
Renewable	928	2
Total	55786	

Under Construction

Type	MW	%
Coal	17480	94
Hydro	811	4
Renewable	245	1
Total	18536	

Total: 74,322 MW **(+) RE 545 MW**

(+) Under Tender

S.No	Project	Capacity	Plan
1	Talcher-III	2 X 660 MW	2019-20
2	Lara-II	2 X 800 MW	2019-20
3	Singrauli-III	2 X 800 MW	2019-20
4	Sipat-III (AUSC)	1 X 800 MW	2019-20

Grand Total: 79,642 MW +

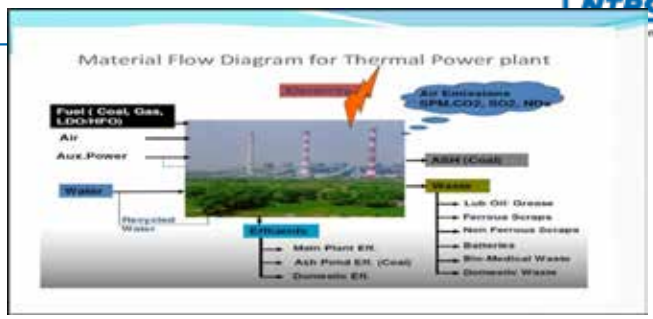
Project (Future)	Capacity (MW)	Plan
Lara-III	2 X 800	2020-21
Gadarwara-II	2 X 800	2020-21
Darlipalli-II	2 X 800	2020-21
Nabinagar-II	3 X 800	2021-22
Meja-II	2 X 800	2021-22
Telengana-II	3 X 800	2021-22
Total	11,200 MW	

Environmental Norms Compliance

India: Emission % by source

Emission (%)	Power	Industry	Residential/Others	Transport
SO_2	46	41	6	7
NOx	20	20	10	40
PM	17	9	47*	17
CO	-	10	11	75

* Wood Burning/Brick Kiln/Generator/Construction/Waste Burning etc.



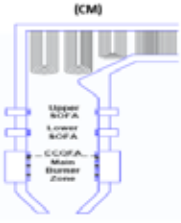
Sulphur Dioxide (SO_2) Emission Control Technologies

Beside above there are other technologies such as Sorbent Injection, Multi-pollutant Control Technology.

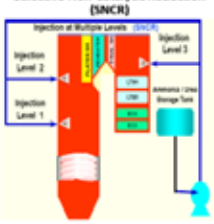
Technologies to limit Nitrogen Oxide (NOx) emission

There are mainly three NOx control technology namely,

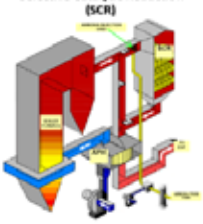
Combustion Modification (CM)



Selective Non-Catalytic Reduction (SNCR)



Selective Catalytic Reduction (SCR)

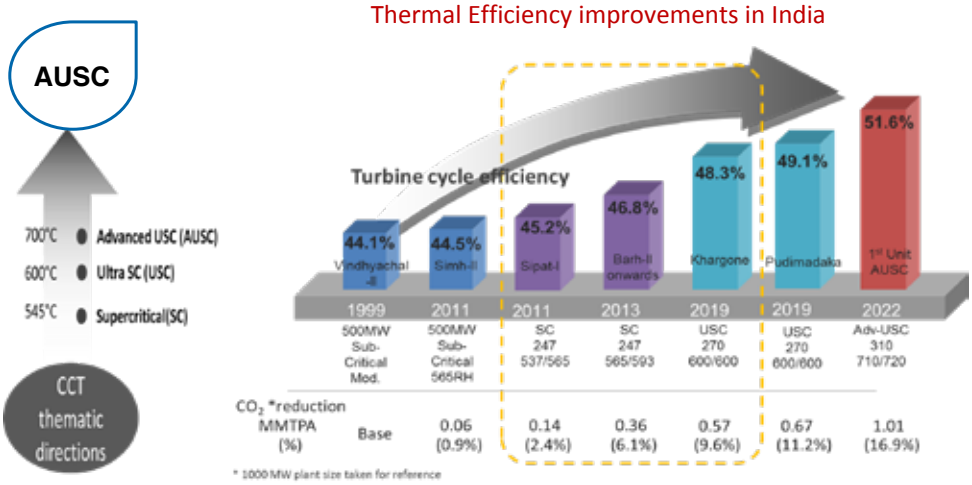


✓These technologies can be implemented individually/ combined as per the requirement

Clean use of Coal prompting higher efficiency quest

One of the most effective ways to increase the electrical efficiency of coal fired plant is to increase the steam parameters.

Thermal Efficiency improvements in India



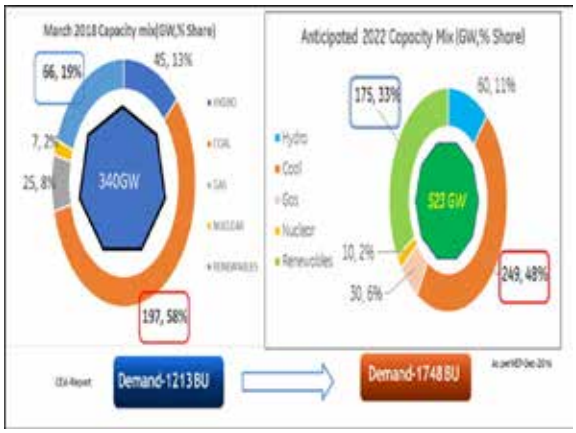
One of the most effective ways to increase electrical efficiency of coal fired plant is to increase steam parameters

Mechanical Innovations are Saturating.... The Future is Digital

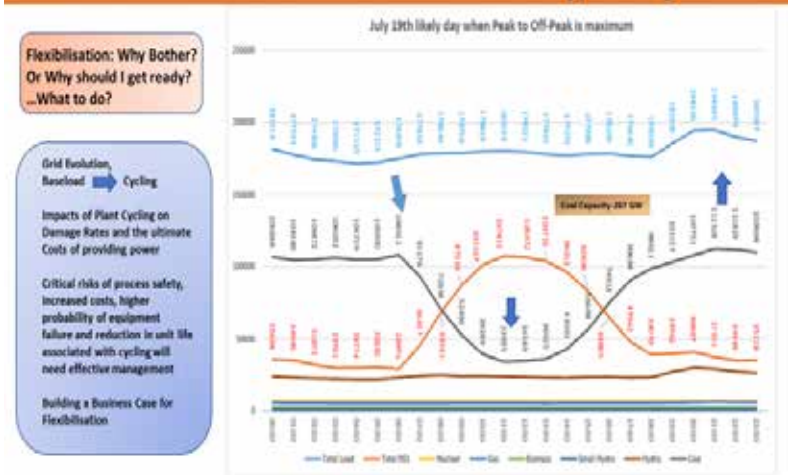
Potential of Digital
- **0.5-1% Efficiency Increase**
- **10-20% O&M Cost Reduction**
- **10-15% NOx Reduction**

The maximum steam parameters are however limited by materials that can operate at these conditions for a practical service lifetime without failure.

Load Cycling & Flexibility



All India Demand Vs Net demand from Coal on a typical day in 2022



Waste to Energy & Biomass Co-firing

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Waste to Energy Demo plant at Varanasi (Gasification based)

Capacity	: 24 Tons Per Day of Municipal Solid Waste
Area required	: 1 Acre
Cost	: ₹ 7.28 Cr
Power output	: 200 kW electric power

24 TPD capacity demo scale plant shall help

- Gain experience on converting biomass gasifier to MSW application
- Evaluate and customize technology for MSW.
- Bench mark various activities (O&M, availability etc.,)
- Study on suitability for distributed generation.

Sl. No	Activity	Time
1	Award of contract	06 April 2018 (NoA issued)
2	Commissioning of Plant	Commissioned in December 2018

WtE Plants tender under process for Surat and Delhi. Biomass Co-firing started at Dadri. Being replicated at all possible coal plants of NTPC. Both require extensive automatic temperature control process among other controls.

Journey of Automation in NTPC

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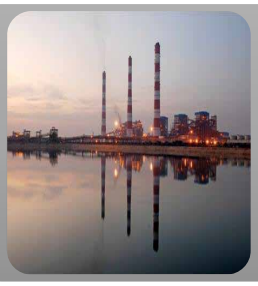
1978-88 (Singrauli-I, Korba-I, Ramagundam-I)

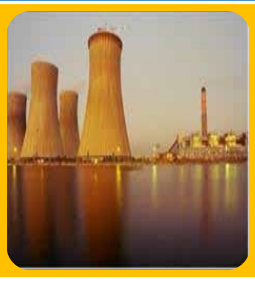
- Relay based system for Boiler protection, Open loop Controls & offsite controls
- Solid state system for closed loop controls & Turbine controls
- Microprocessor based DAS for plant monitoring
- First Training Simulator in Korba Simulator



1986-94 (Farakka-II, NCTPP-I)

- First ever Microprocessor based DDCMIS controls having CRT/KBD operation with 100% Backup devices
- Microprocessor based FSSS as well as for Turbine controls
- First Gas simulator in Kawas

Journey of Automation in NTPC



1994-97 (Vindyachal-II, Faridabad, Simhadri-I,)

- DDCMIS based electrical breaker Controls
- Large video Screen introduced in Main plant control room
- CCTV
- PADO for real time performance Analysis, optimisation and diagnostics

1999-2003(Talcher-II,Ram-III,Rih-II,)

- Remote IO based CW plant controls
- Common control Room for four units in Talcher
- Large scale integration of PLCs with DDCMIS through LAN realised using OPC protocol
- LVS based operation with minimal Backup and LVS annunciation System
- Conceptulised-Control room reduction from 33 to 4

Journey of Automation in NTPC

2003-07(Kahalgaon-II/Sipat)

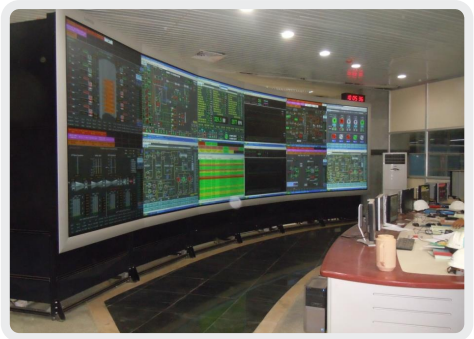
- Two tier LVS for Main plant operation and controls
- Wireless Connectivity with Make up water
- First Supercritical Simulator of India in Sipat-I with replica facility at PMI
- AAQMS system for 20 Plants of NTPC

2007-11 (KDF, Jhajjar, Simhadri-II, Vallur, Bongaigaon, Barh-II, Bulk 660 MW)

- First ever DDCMIS based controls for off site areas with facility of complete inter-operability from any where
- Realising Concept of control room from 33 to 4
- Security Audit and policies framed for DDCMIS Based Network of the entire plant (Bongaingaon)
- Simulator for operators for all New projects
- Introduction of IP based CCTV (Rih-III, Vindhyachal-IV)

Transition in C&I Systems

NTPC-SINGRAULI



NTPC-SIMHADRI

Major Automations in NTPC

DDCMIS based control in main plant and offsite plants

- Distributed Control System(DCS) in Main Plant (SG&TG) ,Water System, Coal Handling, Ash Handling & other offsites areas like CW, CT etc.
- Unified HMIPIS
- FieldBus/ Profibus based controls and instrumentation

DDCMIS based monitoring of Switchgear Automation

- Integration of IEC 61850 Switchgear ring with DDCMIS
- Introduction of IMCC.

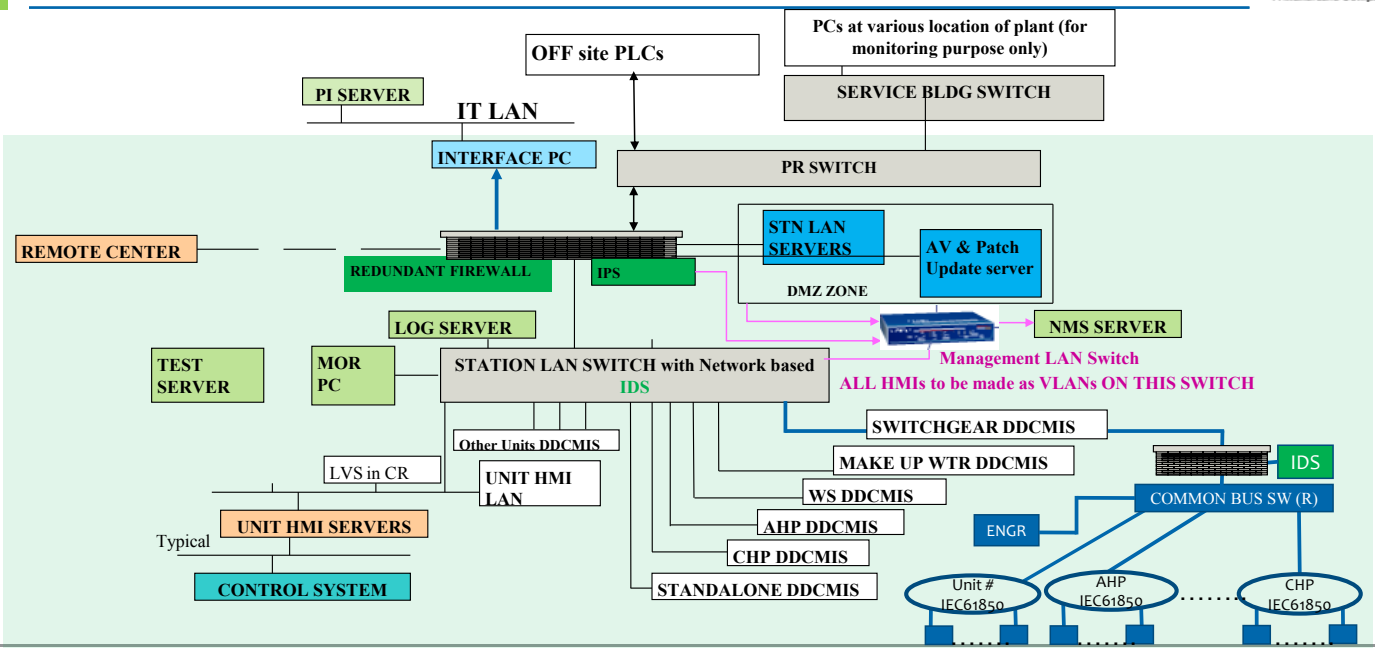
Remote Operation of Hydro power plants

- Centralised operation of hydro power plants from remote.

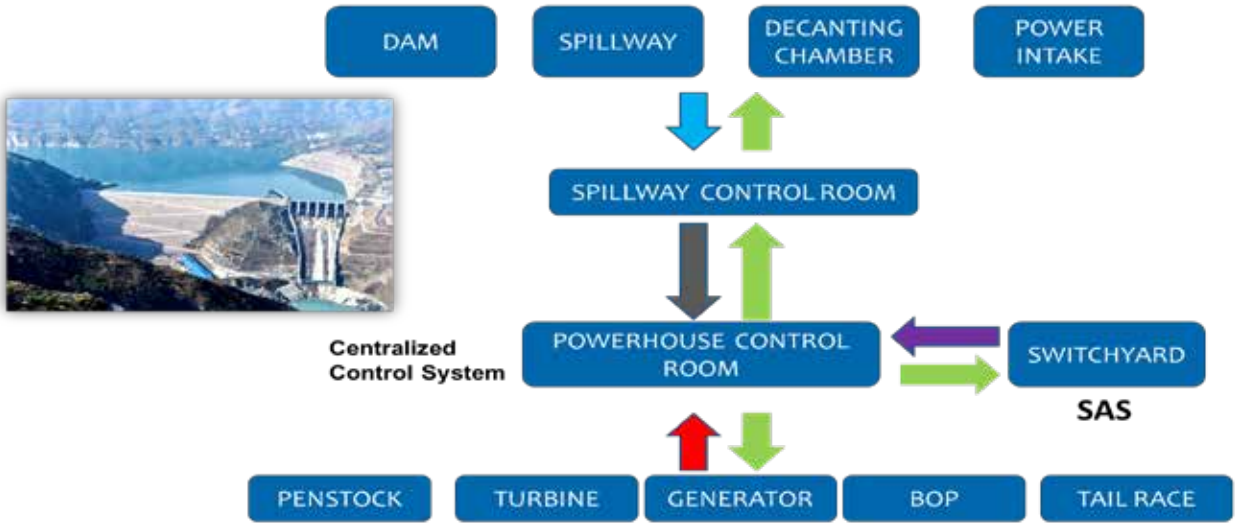
Antriksh

- Centrailsed monitoring of plant parameters & start-ups of NTPC fleet at NTPC,Noida.
- Remote vibration analysis implemented at OS control room-Solution independent of OEM

DDCMIS BASED AUTOMATION (Contd.)



Process Interface at Koldam HEPP of NTPC



Remote Operation of Koldam from New Delhi…

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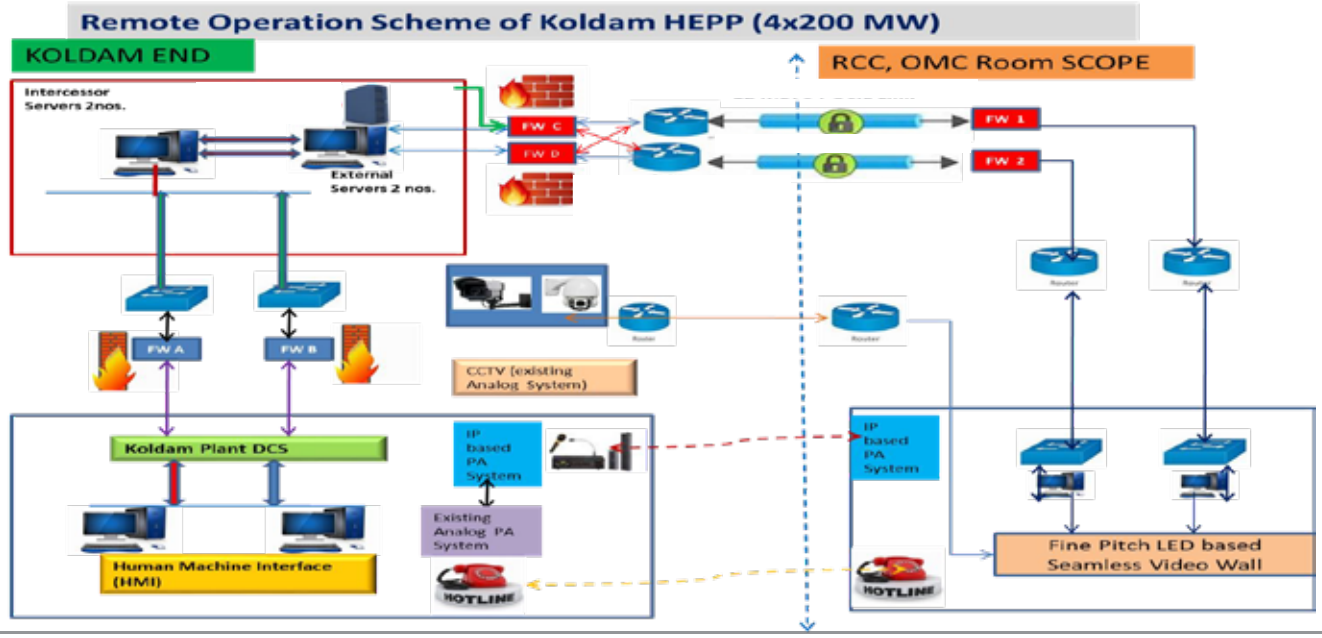

Antriksh- Centralised plant startup monitoring

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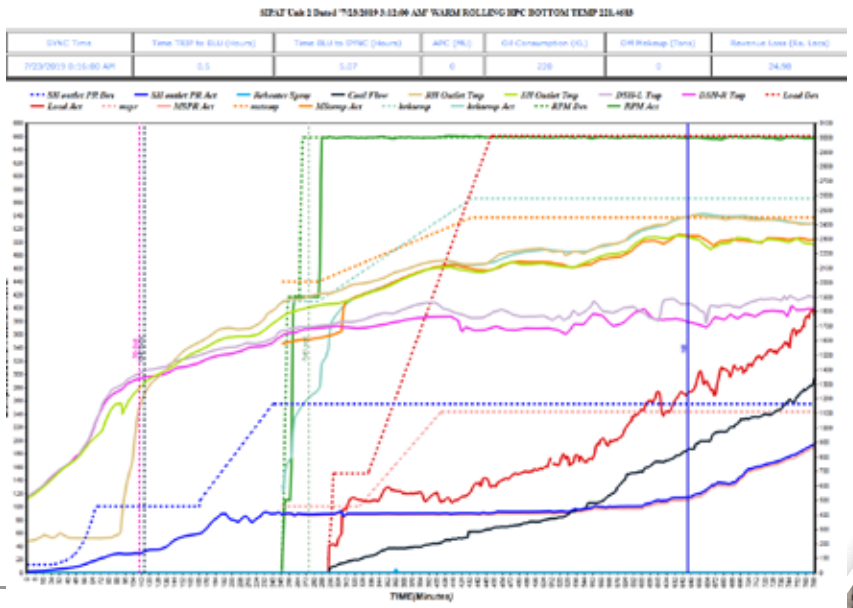
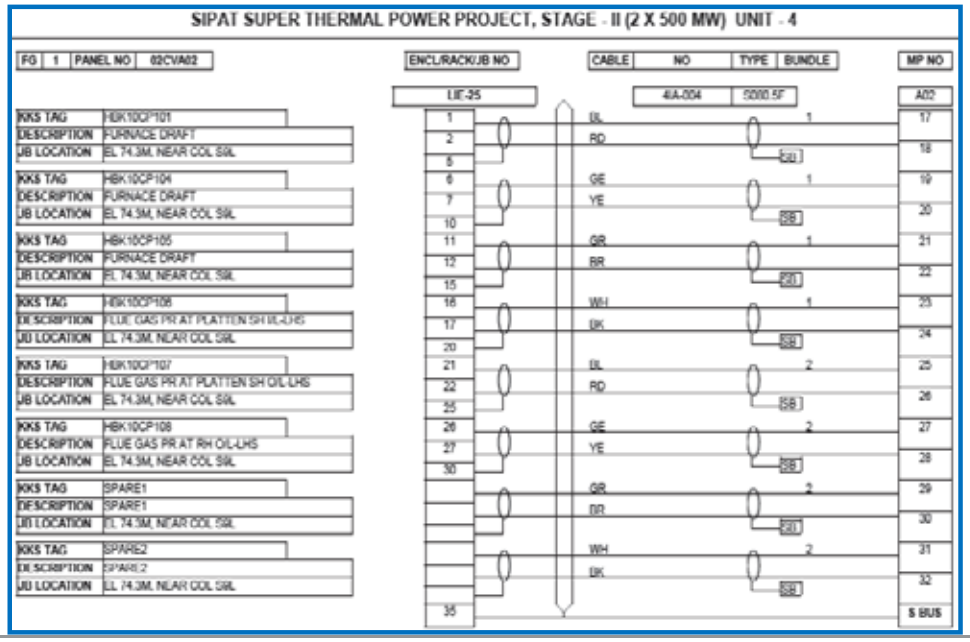
IT Connectivity across all plants

Data of NTPC plants from DDCMIS

NTPC, Noida



Software Developed for Automation of Interconnection Schedule



MANUAL GENERATION
1. Cable No
2. Cable Type
3. Bundle No
4. Pair No
5. Post No
6. MPTB No
7. Spare Generation

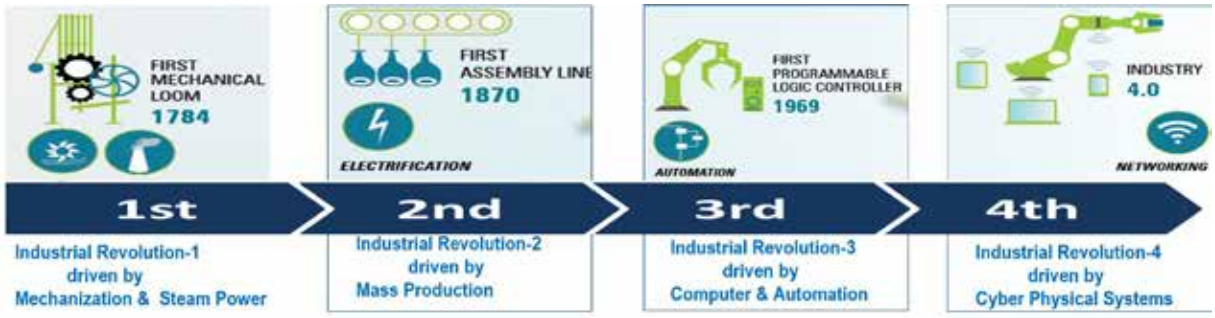
The Digital Transformation Imperative

- Many Industries have witness the Digital Disruption
  - Transport – Uber, Ola
  - Travel – Airbnb, Oyo
  - Banking – Payment Wallets/Banks, E-Banking
- Amazon had the courage to disrupt itself. It launched the kindle e-book reader at expense of its physical book sales. Now Amazon a leader in e-marketplace.
- Many such examples… Google, Facebook, Philips, Tesla

Holistic Digital Transformation – An opportunity for NTPC to improve its bottom line & take the cutting edge.

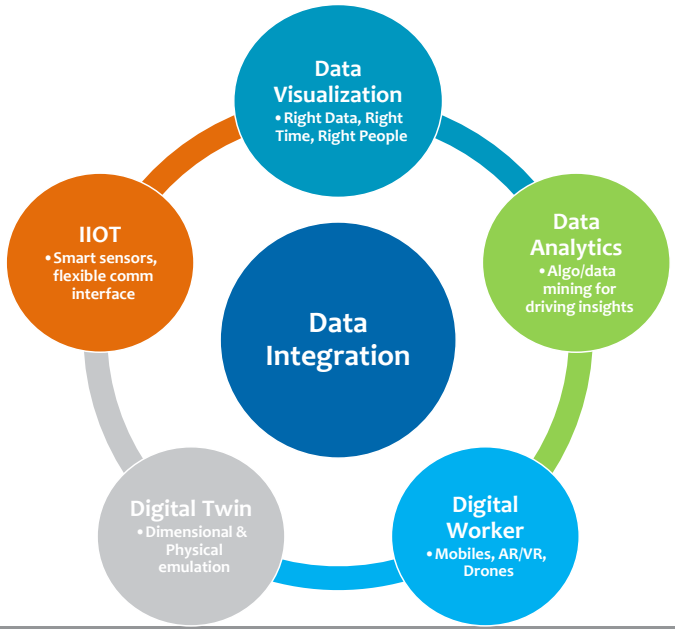
- Digitalization – A way of institutionalizing **Knowledge, Best Practices, Data Driven decision making**
- Leveraging Technology before the competitors, to get the cutting edge.
- Price of Technology is insignificant compared to the benefits.

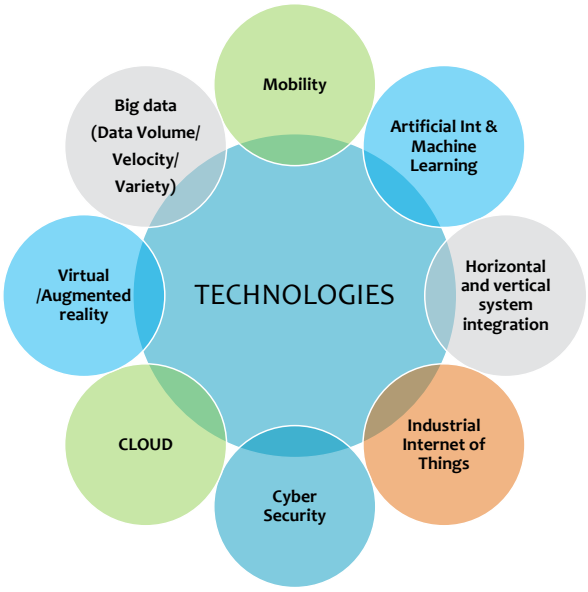
Evolution of Technology



21

Digitalization : Key Elements & Technologies





22

Digital Transformation in NTPC – Major Ongoing Initiatives

Digital Power Plant

- Digitalization in Plant O&M

Integrated Command and Control Centre

- Fleet wide Analytics based Business Optimization – Demand Forecasting (RE, Thermal, Hydro) , Fuel Planning, Market Intelligence – Pan NTPC

Smart Plant Security

- Integrated Physical Security Systems – Being executed for 6 stations

Paperless office, Workflow Automation

- Pradip initiative – Pan NTPC – Under Implementation

Smart Township

- Smart Metering, Integrated Physical Security, Water Management – Being executed for 10 stations

23

Digital Power Plant: The Approach

STRATEGIZE

- EXISTING STAGE ASSESSMENT
- ENVISIONING TARGET STATE
- CHALK OUT INITIATIVES
- DIGITAL STRATEGY & ROADMAP

→ Strategy and Roadmap Finalized

SHOWCASE

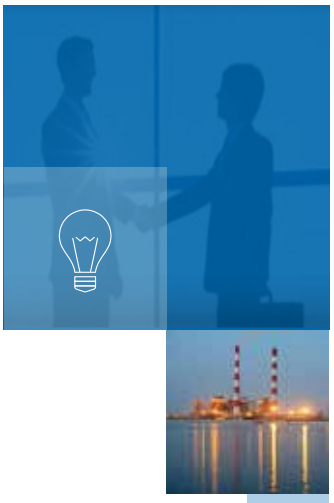
- COMMUNICATE THE STRATEGY ACROSS ORGANIZATION
- PROTOTYPE, EVALUATE & DEMONSTRATE BENEFITS
- TAKE FEEDBACK
- RE-CALIBRATE & REFINE INITIATIVES

→ Pilot all Digital Initiatives in one Station

SCALE & SCORE

- IMPLEMENTATION ACROSS ORGANIZATION
- DEVELOP DIGITAL CULTURE
- CREATE & HARNESS VALUE

→ Scale Successful Initiatives across NTPC Fleet



24

Digital Power Plant – New Initiatives

NTPC A Maharatna Company

BUSINESS OBJECTIVE	IMPROVE OPRN. EFFICIENCY	EMPOWERED WORKER	OPTIMIZE MAINT. COST	REDUCE PREVENTABLE LOSSES	DIGITIZE ASSET & DOC
FOCUS AREA	Operation Efficiency: Heat Rate Improvement; Flexible Operation Support	Improved Worker Productivity: Online expert guidance; Virtual Training; Digital Operator Rounds	Maintenance Efficiency: Minimize unplanned Outage; Right mix of PM/CBM/OH	Improved Process Visibility: Real time Coal Stock; IIOT for monitoring	Digital Twin of Plant: 3-D Walkthrough; One Stop Documentation
INITIATIVE	APC (Advance Process Controls)	ART (AR/VR based Trainings) DIGITAL WORKER	APM (Asset Performance Management)	AMS (Advanced Monitoring of Stockyard) AIG (Application of IIOT in Generation)	AIM (Asset Information Management)

25

New Digital Initiatives : Advance Process Control (APC)

NTPC A Maharatna Company

Business Requirement	Heat Rate Improvement	Flexibalization	Reliability (Reduce Excursion)	Stable Min. Load
Focus Area	Parameter Optimization	Ramp Rate Improvement	Parameter Excursion Reduction	Control loop Optimization
Solution Envisaged	Combustion & Soot Blowing Optimization; Model Predictive & Neural Net Control	Model Predictive Closed loop Pressure Control	Model Predictive Closed loop SH/RH Temperature Control	Auto-tune blocks

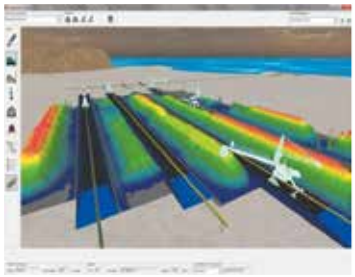
26

New Digital Initiatives : Advanced Monitoring of Stockyard (AMS)

NTPC A Maharatna Company

❖ **Stockyards challenges are:**

- ❖ Frequent hot spot formation.
- ❖ Manual assessment and Record Keeping.
- ❖ GCV Measurement is Manual in laboratory.



This part of power plant is completely manual and need complete automation for effective stockyard management

Digital Solutions:

- 3D Profiling of Coal Stockyard for volumetric analysis
- Hotspot detection
- Automatic Sprinkler Operation
- Enabling Man less operation of SR Machines

Operator can visualize

- **Exact replica of the coal heap**
- **Cross sectional volume and other details available in a particular heap of coal.**
- **Different Color Gradient indicates the different thermograms or temperature zones of the stock yard.**

27

New Digital Initiatives : Augment/Virtual Reality Based Training (ART)

NTPC A Maharatna Company

Virtual Reality based Training Module

- Interactive computer generated experience
- Simulation of real environment
  - Workplace occupational safety and health purposes,
  - educational purposes, and
  - training purposes
- Currently widely used in Aviation, Medicine and Military

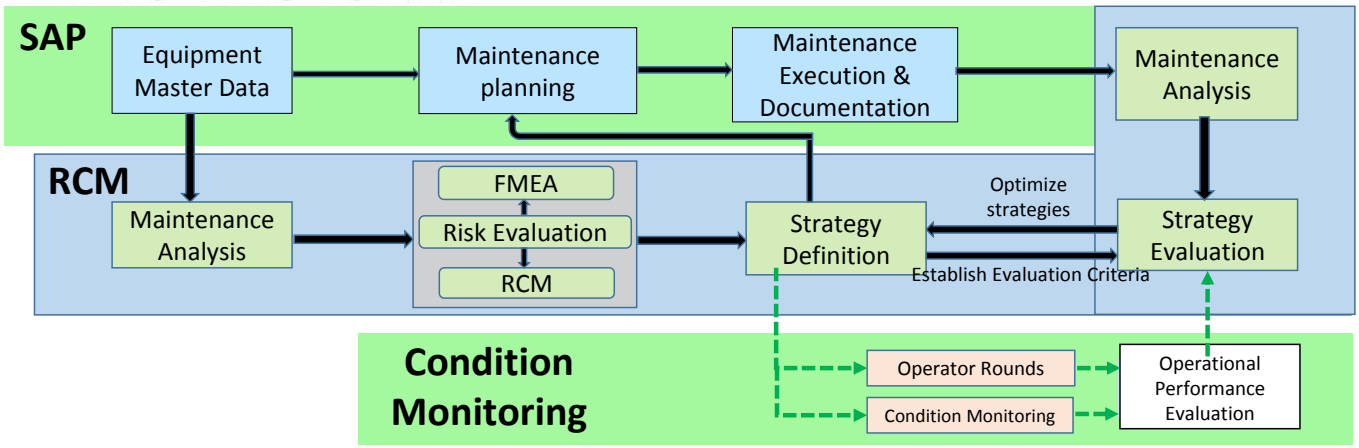
28

New Digital Initiatives : Asset Performance Management (APM)

NTPC A Maharatna Company

✓Reliability Centered Maintenance (RCM) Practice
- ✓Integrated Criticality Analysis
- ✓Device best maintenance strategy mix – PM/CBM/OH
- ✓Root Cause Analysis Libraries to prevent repeated Failures
- ✓Life cycle costing analysis tools

Major Benefits:
- ❑Maintenance Optimization
- ❑Reduction in Forced Outages
- ❑System Driven Decision Making
- ❑Manpower Productivity



29

New Digital Initiatives : Digital Worker

NTPC A Maharatna Company

SMART DEVICE for Field Operator Rounds, Filed Operator Guides, Audio/Video upload, SOP access

DIGITAL HELMET for Remote Assistance/Monitoring, Remote Access of SOPs, Procedure Videos

RTLS for Real time location tracking of Assets

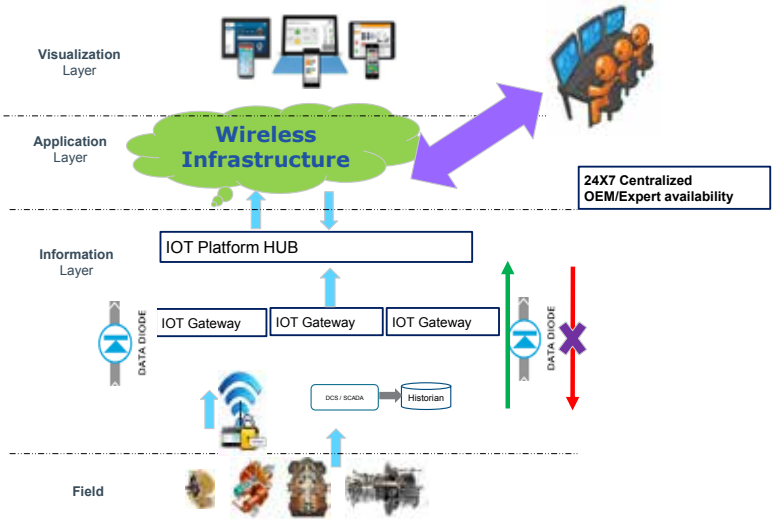
Creating a workforce with digital skills

30

New Digital Initiatives : Application of IIOT in Generating Units (AIG)

✓Augmenting today's handheld based condition monitoring with

- ✓Permanently mounted wireless vibration and skin temp sensors on critical equipment
- ✓ Portable wireless vibration and skin temp sensors for need based wireless assessment
- ✓Humidity and Temperature monitoring in remote equipment
- ✓Voltage level and Lux level sensors in remote pump houses



Innovation using Information & Analytics is the new Mantra !!!

31

New Digital Initiatives : Asset Information Management (AIM)

- **Featured in Gartner's Top 10 Strategic Technology Trends for 2017**

Real Space

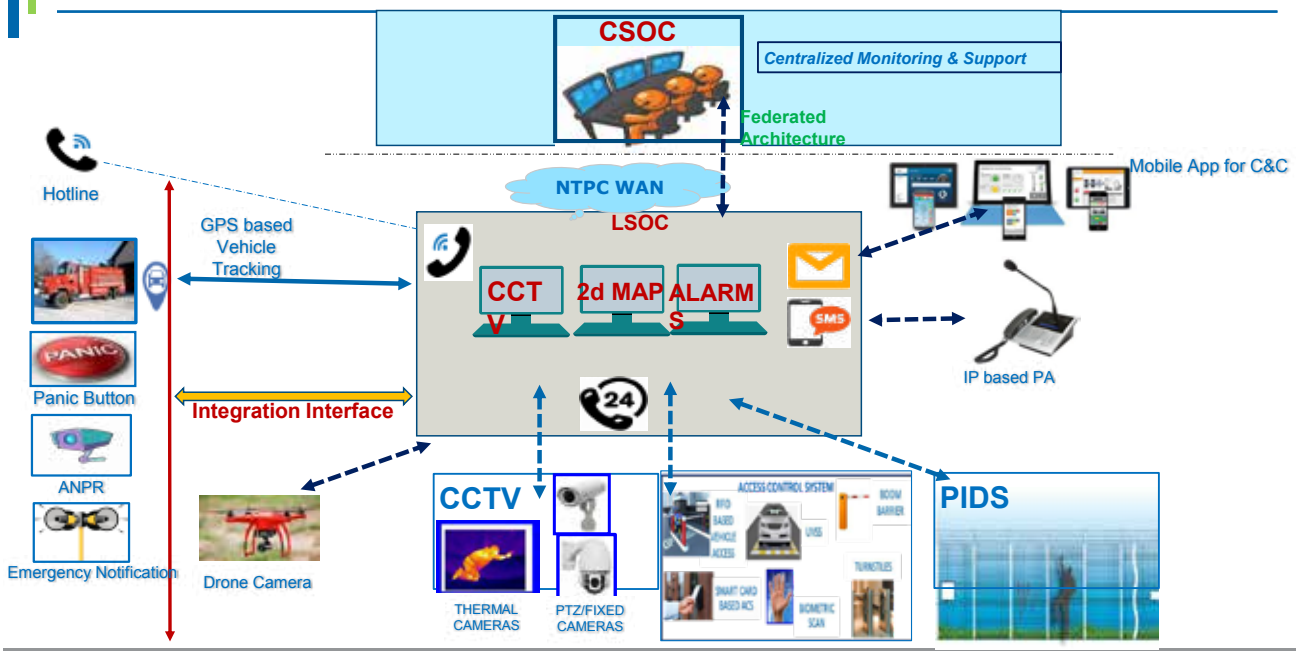
Virtual Space

Dimensional Model
3D model + Life cycle documentation

- DIMENSIONAL DIGITAL TWIN
  - Walk Through
  - One Stop Documentation
  - Training / Maintenance Planning

32

Integrated Security System



PRADIP (PRo-Active and Digital Initiatives to become Paperless)

Smart Townships

Digital Transformation in NTPC - Challenges

- Lack of Digital Maturity Model for Power/Process industries
- Lack of Use cases in many Areas
- Data Integration: For Multiple Sources – Applications not open to Integration
  - Condition Monitoring – DGA, Vibration Data
  - Legacy Control Systems
  - Offline data from operator rounds etc.
- Culture & Mindset
  - Visibility in to work areas
  - Aversion to Change
- Cyber Security

36

Digital Transformation in NTPC - Learnings

- Digital is the new normal….Its an era
- Digitalization of the entire power sector Value Chain holds the key to improving efficiencies
- Digital initiative should be linked to business outcome - Contracts to be performance based
- Quick wins with high business impact will lead the way
- Enterprises should create an digital transformation road map with a phased approach
- Scalable Digital platform to support innovation & meta data integration
- Digital Transformation can create new revenue streams in future
  - Consultancy to other Utilities
  - Data Monetization
- Digitalization is no longer an option… but a necessity

" The best way to predict the future is to create it yourself "

Peter H. Diamandis

37

Thank You

38

Corrosion Resistant Solutions for POWER INDUSTRIES

Plasticon Composites International Contracting BV (PCIC),
the Netherlands,

a Plasticon Group company (Europe), and

EPP Composites Pvt. Ltd., Rajkot,
Gujarat - India,

have decided to join forces, in approaching the Power utility market in India, by way of entering into an agreement in which PCIC provides support in Corrosion resistant Fiber reinforced Plastics (FRP) Technology – Design, Engineering and Project Management. PCIC and EPP recognize a growing need for FRP solutions in Coal fired - Thermal Power Plants, especially in the area of Wet Flue Gas Desulphurization (FGD) systems.

PCIC has over two decades of expertise in the Corrosion & Power Utility Equipment – Design, Engineering, Pioneering FRP Technologies and Capabilities of On-site Filament Winding Technologies of Large Diameter equipments coupled with Global Cases, which makes them an Ideal Partner for India Power - Utility FGD opportunities.

The Partnership with EPP Composites provides a great opportunity for PCIC to gain access to the Indian market. EPP – by virtue of their current business and supplies to various Power Projects followed with an excellent business relationship with key Engineering & End user Companies – is the right partner in this business segment –

Jannes Snel – Global Business Manager - PCIC - BV, Europe.

The Co - operation with PCIC will bring extensive experience on Corrosion Resistant FRP Power Utility Equipment's into India, Which EPP is keen to explore, execute and expand –

Jayraj Shah - Managing Director - EPP Composites, Gujarat-India.

FRP Sorage Tank

Scrubber & Columns

FRP Duct

GRP Spray Systems

FRP Pipes & Fittings

Industrial Filters

FRP Platform, Railings & Staircase

FRP Molded & Pultruded Grating

EPP Composites Pvt. Ltd.

Plot No 2646, Kranti Gate Main Road, GIDC Lodhika Industrial Estate, Kalawad Road, Metoda, Rajkot - 360021, Gujarat, INDIA
Email ID: bd@epp.co.in | Website: www.eppcomposites.com

India's Power Distribution Sector: An assessment of financial and operational sustainability

Ajai Nirula*

*Ajai Nirula is a management consultant and mentor with over forty years of experience in the the power and fertiliser sectors and was a Visiting Fellow at Brookings India. He was also the former Chief Operating Officer at ILFS Energy Development Co. Ltd and Tata Power Delhi Distribution Ltd. Ajai has a Degree in Mechanical Engineering, a Masters in Business Management and an LLB.

This paper is a part of ongoing studies on the the Electricity Distribution sector in India, supported by a number of donors, including the MacArthur Foundation. The author would like to acknowledge inputs from Rahul Tongia and Geetika Gupta and editorial support from Zehra Kazmi, Rohan Laik and Aditi Sundan.

Designed by Mukesh Rawat

Introduction

The Indian power sector value chain can be broadly segmented into generation, transmission, and distribution sectors. At an all-India level, the total installed **generation capacity** was 3,56,100.19 MW as on March 31, 2019 (provisional). The peak load demand of 1,75,528 MW during FY 2018-19 was largely met, considering that the peak load supply shortfall was 1494 MW (0.8%).[1] This indicates that power deficits on account of generation capacity shortfall, which plagued the sector till recently, have been addressed. In the next five years, the Central Electricity Authority (CEA) estimates that existing generation capacity, augmented by power projects to be commissioned during this period, will be adequate to meet the energy demand growth.

In the **transmission sector,** India's regional grids (Northern, Eastern, Western, North-Eastern, and Southern) are currently integrated into one national grid. By the end of the 12th plan period (2012-2017), India had total inter-regional transmission capacity to transfer nearly 75,050 MW. This is expected to increase to about 1,18,050 MW by the end of the 13th Plan (2017-2022) and will be adequate to meet the energy flow requirements across the regions within India.[2]

The distribution sector consists of Power Distribution Companies (Discoms) responsible for the supply and distribution of energy to the consumers (industry, commercial, agriculture, domestic etc.). This sector is the weakest link in terms of financial and operational sustainability. It is worth noting that the total outstanding dues of Discoms payable to generators/creditors as of February 2019 stood at an alarming level of Rs. 418.81 billion, as per data from 58 Discoms reported by 17 participating GENCOs (Generation Companies). This included the overdue amount of Rs. 267.56 billion > 60 days payable to the generators.[3]

Discoms' efficiency and power sector sustainability

Power distribution companies collect payments from consumers against their energy supplies (purchased from generators) to provide necessary cash flows to the generation and transmission sectors to operate. Due to the perennial cash collection shortfall, often due to payment delays from consumers, Discoms are unable to make timely payments for their energy purchases from the generators. This gap/shortfall is met by borrowings (debt), government subsidies, and possibly, through reduced expenditure. This increases the Discoms' cost of borrowing (interest), which is inevitably borne by the consumer. This also undermines the ability of the Discoms to purchase and distribute power to fulfil their Universal Supply Obligation (USO) as defined in the Electricity Act 2003 or borrow for capital expenditure to meet load augmentation and growth requirements. Discoms must therefore, (a) buy cost-efficient power for consumers, (b) ensure supply reliability with quality by minimising losses/leakages (c) accurately meter, bill, and collect payments from the consumers, and (d) thereby, enable timely payments to the generators. These are key steps towards sustaining the entire energy value chain without power supply disruptions.

Since India gained independence in 1947, the central and state governments have launched a number of schemes and initiatives aimed at improving the operations and financial health of Discoms. Despite these steps, their success has been limited so far and the distribution sector continues to be a resource drain on the Indian economy. The power sector has seen multiple interventions by government – financial restructuring/bailout (Ahluwalia Committee 2001, Central FRP Scheme 2012), operations, infrastructure, and technology improvements (APDRP 2001, R-APDRP/IPDS 2008, DDUGJY & SAUBHAGYA 2014/2017, Smart Grid Pilot project & NSGM 2012-15), and structural reform (Electricity Act 2003). UDAY (Ujwal Discom Assurance Yojana) scheme, launched in November 2015, is the latest attempt to address the severe financial stress due to accumulation of debt by the Discoms, with a focus on improving the overall efficiency and financial turnaround.[4]

As the data on distribution sector financials and operations shows, the power sector today faces the critical challenge of avoiding a financial crisis. In all likelihood, another scheme to address the shortfall of UDAY's targets, is on the horizon. The objective of this paper is to critically analyse the performance of Discoms in the context of UDAY, launched by the Government of India almost four years ago, for the operational and financial turnaround of the Discoms.

[1] Central Electricity Authority (CEA), Ministry of Power, Govt. of India. www.cea.nic.in
[2] Power Grid Corporation of India: www.powergridindia.com
[3] Ministry of Power website: www.praapti.in
[4] FRP (Financial Restructuring Program), APDRP/R-APDRP (Restructured-Accelerated Power Development Program), IPDS (Integrated Power Development Scheme), DDUGJY (Deen Dayal Upadhyay Gram Jyoti Yojana, SAUBHAGYA (Sahaj Bijli Har Ghar Yojana), NSGM (National Smart Grid Mission).

This paper also aims to offer an analysis of Discoms' performance, and establish the key areas of focus going forward, with strategies proposed for each focus area.

The UDAY scheme envisages the financial and performance turnaround of India's Discoms. 27 states and five Union Territories have signed up for participation. The scheme's objectives are:

a) Financial turnaround.
b) Operational improvement.
c) Development of renewable energy.
d) Reducing the cost of generating power.
e) Energy efficiency and conservation with the ultimate objective of availability of 24x7 power for all at an affordable price.

Financial losses of Discoms: Current and future perspectives[5]

1. As per the UDAY scheme, for financial turnaround, states will take over 75% of the Discom debt as on September 30, 2015, split as 50% in FY 2015-16 and 25% in FY 2016-17. The states are supposed to issue non-SLR (Statutory Liquidity Ratio) including SDL (State Development Loan) bonds, to take over debt and transfer the proceeds to Discoms in a mix of grant, loan, and equity. Maturity period of bonds would be 10-15 years, and the moratorium period would be up to five years. Rate - G-sec plus 0.5% spread plus 0.25% spread for non-SLR. Borrowing is not to be included for calculating fiscal deficit of the state. The remaining 25% of debt would stay with Discoms in the following manner: issued as state-backed Discom bonds, or re-priced by banks/financial institutions at interest rate not more than bank base rate + 0.10%. States would take over future losses of Discoms as per trajectory in a graded manner. [0% of loss of 2014-15 & 2015-16; 5% of 2016-17; 10% of 2017-18; 25% of 2018-19 & 50% of 2019-20]. Balance losses are to be financed through state bonds or Discom bonds backed by state government guarantee, to the extent of loss trajectory finalised with Ministry of Power. Jharkhand and Jammu & Kashmir to be given special dispensation for takeover of outstanding CPSU dues.[6]

2. This financial restructuring of the debt burden of the state Discoms is 75%-100% complete for individual states, with the overall issue of 86.29% of bonds worth Rs. 2321.63 billion as of December 2018. The aim is to reduce the Discoms' debt by Rs. 3 trillion, resulting in substantial interest burden savings amounting to Rs. 250 billion-300 billion. This is subject to limitation of the markets to absorb these bonds.

3. **Financial losses as of FY 2018:** The scheme aims to substantially reduce the overall Discom losses from Rs. 514.80 billion in FY 2015-16 to Rs. 200 billion by 2018 (as projected by the Ministry of Power). Target reduction of the annual operating losses to Rs. 100-150 billion. The book losses have reduced to Rs. 150.49 billion in FY 2018 from Rs. 514.80 billion in FY 2016.[7]

4. **Future projection of financial losses:** Assuming future energy demand growth at 5%, AT&C reducing by 1% every year from level of 22% in FY 2018, the financial losses of Discoms (overall) will fall to Rs. 180 billion in 2021, from an estimated Rs. 260 billion in FY 2018 (Department Of Power estimate at Rs. 200 billion). Per estimates, the subsidy level will increase to Rs. 955 billion in 2021 from current level of Rs. 800 billion in FY 2018.[8]

[5] ICRA presentation, Discom Finances, Power Distribution In India, Nov. 20, 2018
[6] UDAY website www.uday.gov.in
[7] January 2019 Newsletter: UDAY website. www.uday.gov.in
[8] ICRA presentation, Discom Finances, Power Distribution In India, Nov. 20, 2018

A snapshot of UDAY: National targets

Table 1. UDAY National Dashboard: Overall Target vs Current Achievement Status[9]

Key UDAY Parameter	Target value No./million[10]	Target Date	Achievement March 2018	Achievement Dec. 2018
1. AT&C losses	15%	FY 2019	18.7%	20.00%
2. ACS-ARR Gap	Zero	FY 2019	0.17 Re/kwh	0.33 Re/kwh
3. Feeder metering	100% (98164 no. Rural, 42103 no. Urban)	30thJune 2016	100% completed	100% completed
4. DT Metering	100% (1.536 million – Urban, 4.156 million Rural)	30th June 2017	64% - Urban 61% - Rural	80% - Urban 59% - Rural
5. Consumer indexing/GIS	100%	30th Sept 2018	In progress	In progress
6. Upgradation of DT, meters	100%	31st Dec 2017	In progress	In progress
7. Smart Meters Installation	100% (5.73 million) 100% (18.43 million)	>500-kwh Dec 2017. >200<500 kwh Dec 2019	In progress In progress	4% - Dec 2018 2% - Dec 2018

Note: For field/site operational parameters like Feeder, DT metering, consumer indexing/GIS, smart meters, etc. these are moving targets due to increasing numbers of consumers/energy consumption load being added since UDAY scheme started in November 2015).

Performance analysis:

Table 1 above compares targets set out under with the actual achievement as of March 2018 and December 2018.

1. Aggregate Technical & Commercial Loss (AT&C).

The AT&C loss reduction from 26% (2015-16) to 15% overall (Target for March 2019) was projected to contribute around Rs. 550 billion in four years. The AT&C loss at all-India level was 18.7% in FY 2018 and projected to reduce to around 18% in FY 2019. This value falls far short of the 15% overall loss level target set by UDAY for FY 2019.

At state-level, in March 2018, 14 Discoms reported loss reduction below the target level of 15% AT&C, eight of which are in the states of Gujarat, Karnataka, and Andhra Pradesh. This trend continued in December 2018. However, Discoms in the the states of Uttar Pradesh (33.08% in March 2018 to 31.24% in December 2018), Haryana (23.11% in March 2018 to 18.99% in December 2018) Madhya Pradesh (29.74% in March 2018 to 31.41% in December 2018), Punjab (29.67% in March 2018 to 20.02% in December 2018), and Rajasthan (26.01% in March 2018 to 24.08% in December 2018) either recorded increase or maintained significantly high AT&C losses.[11]

[9] UDAY website. www.uday.gov.in. (State Health Cards) Site accessed on April 29, 2019

[10] Amandeep Kaur and Lekha Chakraborty. Conference on Power Distribution in India, 'Opportunities Among Challenges', Key trends, Outlook, Nov.19-20, 2018. Table A16 Aggregate operational indicators under UDAY, October 2018.

[11] UDAY website. www.uday.gov.in. (State Health Cards) Site accessed on April 29, 2019.

2. ACS (average cost of supply per unit of power) and ARR (average revenue realised per unit) i.e. ACS-ARR gap:

On an overall basis, the January 2019 newsletter on UDAY website shows that the ACS-ARR gap of Re. 0.58/unit in 2015-16 came down to Re. 0.17/unit in 2017-18, with estimated reduction of Rs. 360 billion in book losses. A trend reversal (deterioration) is indicated as the national dashboard of UDAY website depicts the ACS-ARR gap to be Re 0.33/unit as on December 2018 after tariff revisions for 25 out of 27 states.[12] (These are the tariff revisions by respective state regulators that resulted in 0.33/unit ACS-ARR gap – timing of regulatory orders is during the year up to December 2018, as per data on the UDAY website).

3. Feeder metering, DT metering, Consumer indexing, GIS (geographical information system), Upgradation of DT (distribution transformer), metering, & smart meters.

Feeder & DT metering, consumer indexing, and GIS are essential enablers for a Discom to do energy accounting of its distribution, to precisely identify pockets of high-energy losses like theft etc., and take enforcement action measures. While metering at 11 KV feeder level is 100% the downstream elements of DT metering, consumer indexing is lagging with respect to completion dates.

As the way forward on AT&C loss reduction, the Ministry of Power had requested states to focus in FY 2018 on loss reduction in 189 divisions in eight states with AT&C losses>40%. By identifying specific areas (divisions) representing high losses to focus on, it is estimated that Rs. 85 billion/annum savings will accrue if losses are reduced by 50% (40,000 Mus to 20,000 Mus) in these 189 divisions.[13]

The installation of Smart Meters will provide new services and automated integration with IT backend of Discoms, but is not an essential prerequisite for AT&C loss reduction. Discoms from Delhi, Mumbai, Ahmedabad, Kolkata, and Gujarat operating with present generation of ordinary electronic meters, have achieved AT&C loss reduction level below 15%.

In Table 2 below, we look at the factors that led to increase of revenue of the Discoms and reduction of book loss in FY 2017-18.

Table 2. Factors contributing to revenue increase in FY 2017-18.[14]

Parameter	Rs. (In billion)	%
FY 17 total income	4840.81	-
FY 18 Increase including subsidy booked:	-	-
1. Billing efficiency	54.03	8
2. Tariff hike	225.30	34
3. Energy supply	280.53	42
4. Other income	105.07	16
TOTAL INCREASE FY 18	664.94	100
FY 18 total income	5505.75	-

[12] January 2019 Newsletter and Consolidated All India Data accessed on April 29, 2019: UDAY website. www.uday.gov.in
[13] January 2019 Newsletter: UDAY website. www.uday.gov.in
[14] January 2019 Newsletter: UDAY website. www.uday.gov.in

Analysis of revenue increase:

1. **An improvement of 1% in the billing efficiency** resulted in an increase of Rs. 54.03 billion in revenue (including subsidised consumers) at national-level. This is a gain from the improvement of the internal operations of the Discoms. However, this gain contributes a meager 8% to the total revenue increase in FY 2017-18.

2. **Tariff hikes contributed Rs. 225.30 billion — a 34% revenue increase in FY 2018,** i.e., a higher billing rate for the same amount of input energy. This is a regulatory benefit which can be attributed to pro-active actions of both regulators and Discoms across states, enabled by the tariff order notifications issued by 25 out of 27 states. However, this is not a direct parameter reflecting the improved operations efficiency of the Discoms.

3. **Energy supply: The revenue increase due to higher energy consumption was Rs. 280.53 billion – 42% of the total revenue increase in FY 2017-18.** The billed energy increased from 694 billion units in FY 2016 to 824 billion units in FY 2018, a trend that is reflected here.[15] This benefit to the Discoms came from improving reliability of power supply, making power available for longer duration (lesser power cuts), and higher energy consumption from both existing and new consumers during the same period. However, the cost of higher sales was not fully recovered due to tariffs being below cost reflective level (ACS-ARR gap widening).

The larger question is whether Discoms will be able to make timely payments to generators and suppliers. To assess this, we must evaluate indicators of financial performance, which are:

a) Outstanding dues of power charges payable to yearly power purchase expense and ratio. (Table 3).
b) Receivables outstanding from consumers (payables to Discoms), yearly turnover, ratio. (Table 4).
c) Outstanding dues of Discoms.[16]

Ten states which contribute more than 80% of the cumulative input of energy among UDAY, are used for this comparison – Uttar Pradesh (UP), Madhya Pradesh (MP), Maharashtra, Rajasthan, Punjab, Haryana, Gujarat, Karnataka, Andhra Pradesh (AP), and Tamil Nadu (TN).

Table 3. State Discoms: Outstanding dues of power charges payable to yearly power purchase expenditure as on December 31, 2018[17] (Rs/billion)

State	Power charges payable (Rs/billion)	Yearly Power purchase exp (Rs/billion)	Payables to yearly purchase (in days)
Gujarat	0	383.4485	-
Karnataka	115.6684	319.5380	132
Andhra Pradesh	105.1241	297.0783	129
Maharashtra	59.3591	618.1363	35
Tamil Nadu	62.9894	500.3873	46
Uttar Pradesh	223.7457	551.2321	148
Haryana	0	282.1210	-
Madhya Pradesh	28.6005	297.0831	35
Punjab	21.2090	212.9179	36
Rajasthan	110.1498	358.9709	112

[15] The PFC (Power Finance Corporation Ltd) report on "Integrated Ratings For State Power Distribution Utilities", July 2018
[16] Data from Ministry of Power website: www.praapti.in, ICRA Research, external studies
[17] UDAY website. www.uday.gov.in. (State health cards). Site accessed on April 29, 2019

From Table 3 above, among states, Karnataka, Andhra Pradesh, Uttar Pradesh, and Rajasthan have very high levels of power charges payable (in no. of days of yearly purchase expenses) ranging from 112 days to 148 days. Madhya Pradesh, Maharashtra, Tamil Nadu, and Punjab have much lower payable levels. Gujarat and Haryana have indicated zero amounts under this head in their respective state dashboards.

a) **The total outstanding dues of Discoms as of February 2019 stood at Rs. 418.81 billion,** according to data from 58 Discoms as per 17 participating GENCOs. This includes Rs. 267.5577 billion overdue amounts > 60 days payable to generators in February 2019 as compared to 159.4225 billion – clear sign of deteriorating ability of the Discoms to make timely payments. Major overdues were to private generators (51.84%) and NTPC (38.71%) as of February 2019.[18]

b) Among the **states lagging in their payments**, the outstanding amounts due since (max) days/state's average amount payable, are the following Discoms: Uttar Pradesh (452 days/Rs 62.39 billion), Rajasthan (639 days/Rs 21.57 billion), Madhya Pradesh (624 days/Rs. 18.29 billion), Punjab (607days/Rs 9.93 billion), Haryana (637 days/Rs 10.04 billion), Karnataka (611 days/Rs. 42.90 billion), Andhra Pradesh (637 days/ Rs. 38.00 billion), and Tamil Nadu (610 days/45.61 billion). **States making timely payments** are Gujarat, West Bengal, Jharkhand, Orissa, Chhattisgarh, and Himachal Pradesh.

c) Clearly, on an average, there are delayed payments of > 600 days. This represents liquidity crunch within Discoms, resulting in major delays of payments to generators. Data from Government of India websites PRAAPTI and UDAY corroborates and supports this conclusion.

Discom receivables

Table 4 shows that large amounts of power receivables are outstanding in terms of days of turnover for all the states except Gujarat.

Table 4. DISCOM receivables outstanding as on December 31, 2018

State	Power receivables outstanding (Rs/billion)	Yearly turnover (Rs/billion)	Receivables to yearly turnover (In days)
Gujarat	2.7652	429.1761	2
Karnataka	73.8406	284.4011	95
Andhra Pradesh	65.8993	280.4364	86
Maharashtra	173.03	704.3660	90
Tamil Nadu	84.5409	492.0107	63
Uttar Pradesh	316.7291	494.5907	234
Haryana	74.2521	252.9823	107
Madhya Pradesh	87.1720	208.6019	153
Punjab	20.6975	228.1405	33
Rajasthan	53.6470	415.9904	47

Table 4 suggests that large amounts of revenues of states are locked up (unrecovered from consumers) in the range of three to eight months of turnover for six states and one to two months for three states. Gujarat is a great example to follow. (The data in both the tables speaks – Gujarat has almost nil payables or receivables!)

[18] The Ministry of Power website www.praapti.in - (Payment Ratification and Analysis in Power Procurement for bringing Transparency in Invoicing of Generators). Site data accessed on May 1, 2019

Table 5: State Discoms – Comparison of customer receivables and power charges payable in Rs. (billion):

State	Power receivable Outstanding	Power procurement charges payable
Gujarat	2.7652	0
Karnataka	73.8406	115.6684
Andhra Pradesh	65.8993	105.1241
Maharashtra	173.03	59.3591
Tamil Nadu	84.5409	62.9894
Uttar Pradesh	316.7291	223.7457
Haryana	74.2521	0
Madhya Pradesh	87.1720	28.6005
Punjab	20.6975	21.2090
Rajasthan	53.6470	110.1498

From the data in Table 5, we can infer that Maharashtra, Tamil Nadu, Uttar Pradesh, Haryana, Madhya Pradesh, and Punjab can fully liquidate their power charges payables if they can recover the total power receivables outstanding from their consumers. At a ground-level, there will be amounts locked in issues like payment and receivable disputes, legal cases, etc. **Therefore, it is clear that if Discoms focus on the release of such amounts, revenue billing and collection areas, a significant amount of power purchase payables to generators can be liquidated.**

How are Discoms managing costs/cost recovery?

Cost coverage ratio:[19] In FY 2017-18, the cost coverage ratio for 25 of the 41 individual Discoms that were rated, remained below 90%. This was mainly due to the substantial increase in expenses of administrative costs, coal cost, and non-cost reflective tariffs. States of Gujarat, Andhra Pradesh, Rajasthan, and Maharashtra recorded major reduction of gap in their costs. However, the cost coverage gap widened or remained high for Uttar Pradesh, Haryana, Madhya Pradesh, Punjab, Tamil Nadu, Chhattisgarh, Mizoram, Meghalaya, and Jammu & Kashmir. Zero gap targets were achieved by Himachal Pradesh, Rajasthan, Maharashtra, and Gujarat.[20] Power purchase cost, after remaining steady for two years at Rs. 4.20/kwh increased to Rs. 4.25/kwh in the first quarter of FY 2019 due to hike in coal and freight prices, according to data available at the UDAY portal.

Trends analysed earlier are further established from recent data accessed from the UDAY website on October 8, 2019 which shows deterioration in key parameters – for example, AT&C loss level at 22% for 20 states and the ACS-ARR gap at Rs 0.40 per unit for 19 states. While, urban DT metering has reached 86% and feeder segregation increased to 77%, other parameters indicate slow progress. Similarly, as of August 2019, for the 60 Discoms, (the overdue outstanding amount ballooned to Rs 595 billion (of which Rs 463 billion-77% is > 60 days overdue).[21]

Further, Discoms owed Rs 32 billion to renewable energy generators. As a measure to arrest this, the government has intervened and announced the new letter of credit (LC) mechanism effective from August 1, 2019. 'Regulatory assets' (or the past outstanding amounts of Discoms payable to generators, recognised by the regulators) reached Rs 770 billion.[22] Besides providing for interest cost, timely tariff revisions are required to limit increases to the regulatory assets while liquidation is another matter. The Vision 2024 policy document by Ministry of Power, National Electricity Policy (NEP) for Distribution by CEA (Central Electricity Authority), new tariff policy etc., are expected to outline future actions for the distribution sector. While results clearly have fallen short of targets, the impetus provided by UDAY for improving the distribution sector in terms of the financial and operational viability needs to be maintained.

[19] Cost coverage ratio= (Revenue realised from sale of power + Other income + Subsidy received) / (Total Expenditure booked)
[20] The PFC (Power Finance Corporation Ltd) report on "Integrated Ratings For State Power Distribution Utilities", July 2018
[21] www.praapti.in (accessed on October 8, 2019)
[22] Risks and mitigants for securitization of regulatory assets: India Ratings and Research Pvt Ltd., May 20, 2019

Key takeaways and areas of focus

While the Discom book losses have declined as an overall measure, severe financial stress in the distribution sector is evident from the analysis presented. Sub-optimal operational performance trajectory in parameters like AT&C loss reduction (projected) at 18% for FY 2019 against target of 15%, ACS-ARR gap increase, operational target slippages (feeder segregation, DT upgradation & metering, consumer indexing, GIS, etc.), have hindered Discoms from pinpointing the energy losses accurately. Similarly, financials have been impacted adversely due to the widening of ACS-ARR gap, as the energy costs increases on one side have not been matched by the cost reflective tariff increases from the regulatory end.

The steady deterioration in the ability of the Discoms to pay the generators, due to large amounts of receivables pending collection from consumers, has created "stressed assets", especially among the IPP's (Independent Power Producers). This is a major limitation in ensuring reliable 24x7 energy supply with quality service.

Areas of focus and future strategy:

1. The results trajectory of AT&C loss reduction efforts has been slow and erratic. At the macro-level, 189 divisions across eight states contribute losses of 40,000 million units of energy and annual revenues of Rs. 170 billion. While feeder metering is 100% complete, at the micro-level, the distribution transformer (DT) metering progress lags (as on December 2018) in both urban and rural segments, at 80% and 59% of the target achievement. Similarly, completion of consumer indexing, GIS, DT & meter upgrades are also behind target (Table 1). Additionally, precise accounting of subsidised energy supply to the agriculture sector by metering and segregation of agriculture/rural & urban feeders needs to be completed.

2. The key takeaway is that these enablers should be completed with minimum delay. This will ensure accurate energy accounting and audit for the identification of high-energy loss pockets (DT's and consumers), which represent low hanging fruits at the micro-level.

3. The ACS-ARR Gap (Table 1) has widened from Re. 0.17/unit in 2017-18, to Re 0.33/unit as on December 2018 after tariff revisions for 25 out of 27 states. Tariff hikes contributed Rs. 225.30 billion — a 34% revenue increase, in FY 2018. However, there is limited upside available here for future revenue increase as bulk energy consumers (industry, commercial etc.) are already burdened with high tariffs. With alternatives available — such as cheaper power from renewable generation — power exchange (markets), Discoms are in danger of losing such high-tariff paying consumers who essentially subsidise other categories, thereby affecting their financial sustainability. Discoms need to optimise the power purchase cost as well as their own distribution costs to improve service and quality of power supply to consumers. However, cost reduction of power purchases locked in long-term PPAs (Power Purchase Agreements) with generators, accurate demand forecasting, and national merit order linked back-down of generation are the major management challenges ahead for Discoms.

4. Overall Discom revenue (Table 2) increased by Rs. 54.03 billion on improving the billing efficiency alone by just 1% in FY 2018. With AT&C loss level at 20% in December 2018 and 18% projected for March 2019, this area is clearly a low hanging fruit for improvement. This is corroborated by the revenue lost due to low billing and collection efficiencies ranging from 65% to 85% in FY 2018.[23] The strategy ahead is to focus on the accurate metering–billing-collection-audit cycle, based on actual energy consumption of consumers, using IT enabling for improving billing & collection efficiency.

5. Energy purchase payments outstanding for Discoms to generators reached a level of Rs. 418.81 billion in February 2019. This included Rs. 267.56 billion overdue amounts > 60 days payable to generators as compared to Rs.159.42 billion in February 2018 – a clear sign of the deteriorating ability of Discoms to make timely payments. Major overdues were to IPP's (Private Generators 51.84%) and National Thermal Power Corporation Ltd. (38.71%) as of February 2019.[24]

[23] Data from the "Integrated Ratings For State Power Distribution Utilities", July 2018

[24] The Ministry of Power website www.praapti.in - (Payment Ratification and Analysis in Power Procurement for bringing Transparency in Invoicing of Generators). Site data accessed on May 1, 2019

Tables 3 & 4 clearly suggest that by timely and efficient collection of energy payments overdue from consumers, delayed/outstanding payments of generators can be largely liquidated. Use of automated processes by Discoms for accurate billing and collection of payments due to Discoms aided by timely release of subsidy payments by state government is a solution.

6. The social objective to provide electricity access to all unconnected households across India (SAUBHAGYA) has largely been met by March 2019 with over 25 million new households being connected. Their aspiration of 24x7 and reliable power supply has to be met. These new consumers represent challenges of locations in far-flung areas, some with low literacy levels and paying capability and lack of knowledge in energy efficiency. Discoms will need to establish processes for consumer education, maintain energy equipment (transformers, conductors, meters etc.), deliver bills, establish payment/collection avenues, and address consumer grievances. These aspects will increase the cost to serve and a lowered revenue recovery-to-effort ratio and may result in revenue losses to the Discoms in this consumer segment in the short term. Timely and accurate billing with focused collection efforts of revenue, consumer communication, education, and complaint resolution by the Discoms is the way forward.

Conclusion

The Indian power sector is listed as a concurrent subject in the Constitution of India, where both center and states have control. Therefore, success of power sector policy and execution has to have a buy-in of both the stakeholders. This applies in particular to distribution reform policies where regional dynamics and priorities vary. All the stakeholders in the federal structure — Center & State, Political, Bureaucracy, Technocrats, Regulators, Consumers etc., the complete ecosystem has to contribute towards a common goal. Despite obvious challenges, success stories of states such as Gujarat, Karnataka, Andhra Pradesh, among others, and private Discoms operating out of Delhi, Mumbai, Kolkata, Ahmedabad, and others are available for emulation in terms of world-class performance, best practices, and benchmarks. It is more than likely that, a revised UDAY 2.0 with reworked targets enabled by technology enablement and interventions with adequate funding is on the anvil.

Hence, by focusing on key result areas, following a pragmatic strategy, and balancing diverse stakeholder interests, it is possible to achieve distribution sector financial sustainability on a pan-India basis.

Endnotes:

1. Central Electricity Authority (CEA), Ministry of Power, Govt. of India. www.cea.nic.in
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13. Amandeep Kaur and Lekha Chakraborty. Conference on Power Distribution in India, 'Opportunities Among Challenges', Key trends, Outlook, Nov.19-20, 2018.

INDIA ENERGY FORUM

Implementation of Environmental Norms

Status, issues and challenges

By

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Implementation of Environmental Norms

Status, issues and challenges

By B.C.Mallick, Chief Engineer, CEA

EARLIER EMISSION NORMS FOR TPS

Emission parameter	Limiting Values
Suspended Particulate Matter (SPM)	Less than 210 MW (1989) : 350 mg/Nm^3 210 MW or more(1989) : 150 mg/Nm^3 The above limits were further reduced to 100 mg/Nm^3 in 2003 under Corporate Social Responsibilities. Limit of 50 mg/Nm3 being specified on case to case basis depending on the area.
NOx	None for coal based stations
SOx	None, stack provided for dispersion <500 MW - 220 m >=500 MW - 275 m FGD space provision for units size 500 MW and above after year 2003.
Mercury	No Norms
Water Consumption	No Norms

New Environment Norms

Emission parameter	TPPs (units) installed before 31.12.2003	TPPs (units) installed after 01.01.2004 and up to 31.12.2016	TPPs (units) to be installed from 01.01.2017
Particulate Matter	100 mg/Nm^3	50 mg/Nm^3	30 mg/Nm^3
Sulphur Dioxide (SO_2)	600 mg/Nm^3 for units less than 500MW capacity	600 mg/Nm^3 for units less than 500MW capacity	100 mg/Nm^3
	200 mg/Nm^3 for units 500MW and above	200 mg/Nm^3 for units 500MW and above	
Oxides of Nitrogen (NOx)	600 mg/Nm^3	300 mg/Nm^3	100 mg/Nm^3
Mercury	0.03 mg/Nm^3	0.03 mg/Nm^3	0.03 mg/Nm^3
WATER NORMS**	I. All plants with Once Through Cooling (OTC) shall install Cooling Tower (CT) and achieve specific water consumption of 3.5 m^3/MWh within 2 years of notification. II. All existing CT based plants shall reduce specific water consumption up-to maximum of 3.5 m^3/MWh within a period of 2 years. III. New plants to be installed after 1.1.2017 shall have to meet specific water consumption of 2.5* m3/ MWh & achieve zero water discharge.		

→ Revised to 450 mg/Nm^3 → Revised to 3.0 m^3/ MWh

SPM Control Technologies

Technology	Removal efficiency	By Product	Waste water	Advantage
ESP	> 99%	Fly Ash, Bottom Ash	No	Disposable by product
Fabric Filters	> 99%	NIL	No	Disposable by product
Cyclones	75 – 99%	Fly Ash, Bottom Ash	No	Disposable by product
Wet Scrubbers	90 – 99%	Ash + Gypsum	Yes	Can reduce SOx and SPM

PM CONTROL
YEAR WISE ESP UPGRADATION PHASING PLAN

YEAR	Capacity (MW)	Units
2018	500	1
2019	6,020	14
2020	8,655	24
2021	22,645	94
2022	25,605	87
Plan not Available	1,970	12
Total	65,395	232

NOx Control Technologies

Technology	NOx removal efficiency	By product	Waste water	Advantage	Limitation
Combustion Modification	Limits NOx production	Nil	Nil	Minimum investment	Affects Sp. Coal consumption.
SCR	70 – 90%	N_2, Water	Yes	High removal rate	Performance was not satisfactory at high ash coal
SNCR	< 50%	N_2, Water	Yes	Not prone to plugging	Low removal rate. Precise Temp control (870 - 1050 °C).

NOx Control Technologies

- Combustion Modification/ optimisation
  - Low Nox burners
  - Secondary Over Fire Air (SOFA)
- Ammonia based SCR
  - $4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$
  - $2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$
  - $NO + NO_2 + 2NH_3 \rightarrow 2N_2 + 3H_2O$
- Urea based SCR
  - $4NO + 2(NH_2)_2CO + O_2 \rightarrow 4N_2 + 4H_2O + 2CO_2$
- Catalyst necessary for SCR process
  - Titanium Oxide, Vanadium, Molybdenum and Tungsten
- SNCR
  - Reaction of Ammonia or Urea at high temperature without using catalyst
  - Precise Temperature control required

SOx Control Technologies

Technology	SOx removal efficiency	By product	Waste water	CO2 production	Hazardous material
Limestone-based Wet FGD	~ 95%	Gypsum, CO_2	Yes	Yes	No
DSI	50 – 60%	Sodium Sulphate, CO_2	No	Yes	No
Ammonia FGD	~ 99%	Ammonium Sulphate	Negligible	No	Yes (NH3)
Sea-water FGD	90 – 98%	CO_2	Yes	Yes	No
Wet Sulfuric Acid (WSA) process	95%	Sulphuric Acid	No	No	No

SOx Control Technologies

- Wet FGD
  - $CaCO_3(s) + SO_2(g) \rightarrow CaSO_3(s) + CO_2(g)$
  - $Ca(OH)_2(s) + SO_2(g) \rightarrow CaSO_3(s) + H_2O(l)$
  - $CaSO_3(aq) + 2H_2O(l) + ½O_2(g) \rightarrow CaSO_4 \cdot 2H_2O(s)$ (Gypsum)
- Dry Sorbent Injection (DSI)
  - $2NaHCO_3(s) + heat \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$
  - Na2CO3(s) + SO2(g) +1/2(O2)→ Na2SO4(s) + CO2(g)
  - $Na_2CO_3(s) + SO_3(g) \rightarrow Na_2SO_4(s) + CO_2(g)$
- Ammonia FGD
  - $2NH_3 + SO_3 + H_2O \rightarrow (NH_4)_2SO_4$
- Seawater FGD
  - $SO_2(g) + H_2O(l) + ½O_2(g) \rightarrow SO_4^{2-}(aq) + 2H^+$
  - $HCO_3^- + H^+ \rightarrow H_2O(l) + CO_2(g)$
- Wet Sulphuric Acid Process
  - $SO_2 + ½O_2 \rightleftharpoons SO_3$ (Oxidation) (in presence of Vanadium oxide catalyst)
  - $SO_3 + H_2O \rightleftharpoons H_2SO_4$ (g) (Hydration)
  - H_2SO_4 (g) $\rightleftharpoons H_2SO_4$ (l) (Condensation)

Phase wise Installation of FGD (Capacity in MW (Units)):

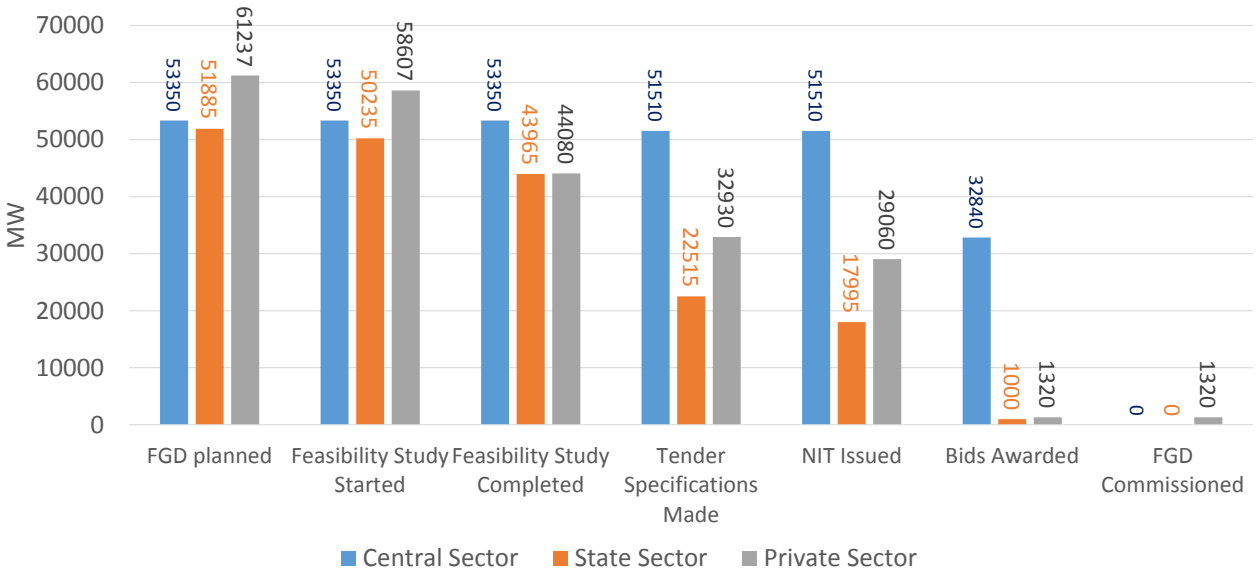
Year	Central	Private	State	Total
2019	3320 (9)	5220 (8)	7870 (22)	16410 (39)
2020	3650 (9)	11700 (23)	6960 (15)	22310 (47)
2021	15510 (40)	21123 (45)	25665 (85)	62298 (170)
2022	30870 (85)	23195 (57)	11390 (42)	65455 (184)
				166473 (440)

All India status of FGD

General Summary								Table A
S.No.	Sector (Capacity in MW)	FGD planned	Feasibility Study Started	Feasibility Study Completed	Tender Specifications Made	NIT Issued	Bids Awarded	FGD Commissioned
1	Central Sector	53350	53350	53350	51510	51510	32840	0
2	State Sector	51885	50235	43965	22515	17995	1000	0
3	Private Sector	61237	58607	44080	32930	29060	1320	1320
	Total	166472	162192	141395	106955	98565	35160	1320

S.No.	Sector (No. of units)	FGD planned	Feasibility Study Started	Feasibility Study Completed	Tender Specifications Made	NIT Issued	Bids Awarded	FGD Commissioned
1	Central Sector	143	143	143	135	135	73	0
2	State Sector	164	158	144	77	59	2	0
3	Private Sector	133	127	88	60	52	2	2
	Total	440	428	375	272	246	77	2

All India status of FGD



Critical units

500 MW Critical Units								Table B
Units > 500 MW & located in areas either critically polluted or having population density > 400/km2								
S.No.	Sector (Capacity in MW)	FGD planned	Feasibility Study Started	Feasibility Study Completed	Tender Specifications Made	NIT Issued	Bids Awarded	FGD Commissioned
1	Central Sector	29320	29320	29320	29320	29320	19820	0
2	State Sector	13980	13980	12280	4800	4800	1000	0
3	Private Sector	13510	13510	9610	7370	4970	1320	1320
	Total	56810	56810	51210	41490	39090	22140	1320

S.No.	Sector (No. of units)	FGD planned	Feasibility Study Started	Feasibility Study Completed	Tender Specifications Made	NIT Issued	Bids Awarded	FGD Commissioned
1	Central Sector	57	57	57	57	57	38	0
2	State Sector	25	25	22	8	8	2	0
3	Private Sector	22	22	16	12	8	2	2
	Total	104	104	95	77	73	42	2

NCR Units

S.No.	Sector (Capacity in MW)	FGD planned	Feasibility Study Started	Feasibility Study Completed	Tender Specifications Made	NIT Issued	Bids Awarded	FGD Commissioned
1	Central Sector	3320	3320	3320	3320	3320	3320	0
2	State Sector	4770	4770	4770	4770	4770	0	0
3	Private Sector	4700	4700	4700	4700	4700	1320	1320
	Total	12790	12790	12790	12790	12790	4640	1320

S.No.	Sector (No. of units)	FGD planned	Feasibility Study Started	Feasibility Study Completed	Tender Specifications Made	NIT Issued	Bids Awarded	FGD Commissioned
1	Central Sector	9	9	9	9	9	9	0
2	State Sector	17	17	17	17	17	0	0
3	Private Sector	7	7	7	7	7	2	2
	Total	33	33	33	33	33	11	2

NCR – Detailed Status

Sector	Developer	Name of Project	FGD Status	Sum of Unit Capacity	Count of Unit No
Central Sector	NTPC	Dadri (NCTPP)	Bid Awarded	1820	6
		Indira Gandhi STPP	Bid Awarded	1500	3
Private Sector	China Light Power	Mahatma Gandhi TPS	FGD operational. Meeting new norms	1320	2
	L&T Power Ltd	Nabha TPP (Rajpura TPP)	NIT issued	1400	2
	Talwandi Sabo Power Ltd	Talwandi Sabo TPS	NIT issued	1980	3
State Sector	HPGC	Panipat TPS	Bid opened	710	3
		Rajiv Gandhi TPS	Bid opened	1200	2
		Yamuna Nagar TPS	NIT issued	600	2
	PSEB	GH TPS (Leh.Moh.)	NIT issued	920	4
		GGS TPS (Ropar)	NIT issued	840	4
	UPRVUNL	Harduaganj TPS	NIT isued	500	2
Grand Total				12790	33

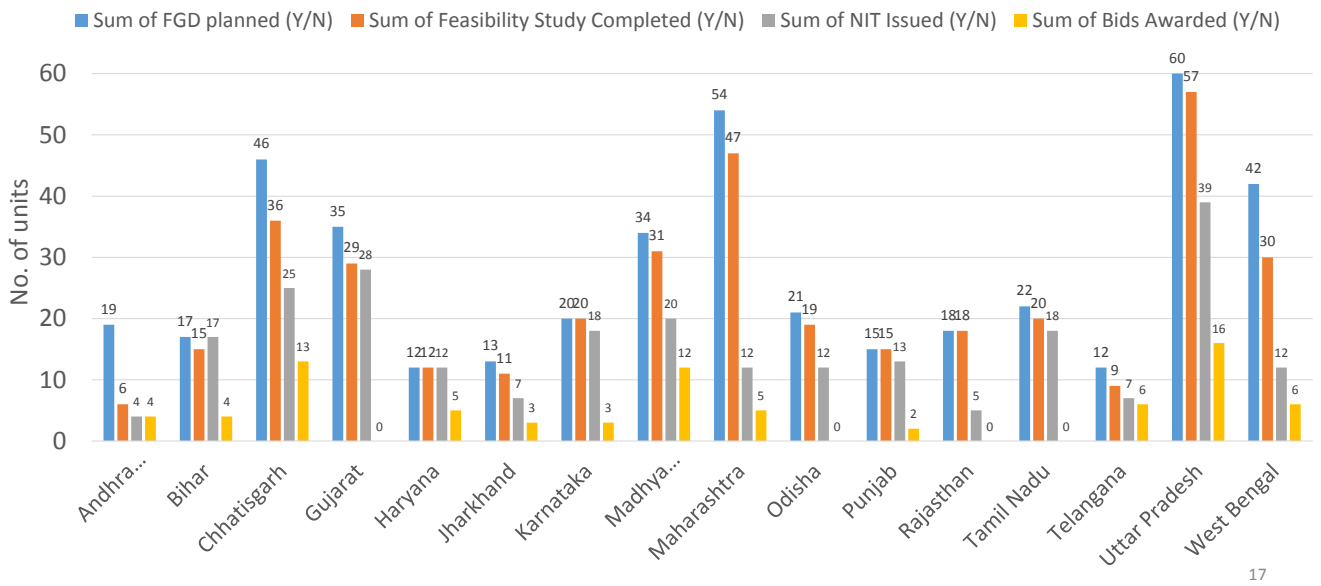
Year –wise breakup of States

State	Years	Capacity	Units
Andhra Pradesh	2019	1320	2
	2020	2240	5
	2021	3270	7
	2022	2600	5
Andhra Pradesh Total		9430	19
Bihar	2020	220	2
	2021	910	2
	2022	4140	13
Bihar Total		5270	17
Chhatisgarh	2020	2870	6
	2021	7020	16
	2022	10540	24
Chhatisgarh Total		20430	46
Gujarat	2020	800	1
	2021	5725	20
	2022	5602	14
Gujarat Total		12127	35
Haryana	2019	5330	12
Haryana Total		5330	12

State	Year	Capacity	Units
Jharkhand	2020	660	4
	2021	1525	3
	2022	2065	6
Jharkhand Total		4250	13
Karnataka	2020	500	1
	2021	2840	7
	2022	5880	12
Karnataka Total		9220	20
Madhya Pradesh	2020	2520	4
	2021	8890	20
	2022	3780	10
Madhya Pradesh Total		15190	34
Maharashtra	2020	2480	4
	2021	12830	38
	2022	4480	12
Maharashtra Total		19790	54
Odisha	2021	2730	8
	2022	4350	13
Odisha Total		7080	21
Punjab	2019	5140	13
	2020	540	2
Punjab Total		5680	15

State	Years	Capacity	Units
Rajasthan	2020	1980	3
	2021	2200	6
	2022	2100	9
Rajasthan Total		6280	18
Tamil Nadu	2019	600	1
	2020	1350	3
	2021	3050	9
	2022	2670	9
Tamil Nadu Total		7670	22
Telangana	2019	1700	3
	2020	1100	2
	2022	2600	7
Telangana Total		5400	12
Uttar Pradesh	2019	2320	8
	2020	4250	8
	2021	7600	22
	2022	6710	22
Uttar Pradesh Total		20880	60
West Bengal	2020	800	2
	2021	3707.5	12
	2022	7937.5	28
West Bengal Total		12445	42
Grand Total		166472	440

State-wise Status of FGD installation



Projects commissioned after March 2018

S.No.	Developer	Project Name	Sector	State	Region	Unit No	Cap. (MW)	Dt of Comm.
1	NTPC	Bongaigaon TPP	Central Sector	Assam	NER	U-3	250	26-03-2019
2	NTPC	Nabi Nagar TPP	Central Sector	Bihar	ER	U-3	250	26-02-2019
3	NTPC	Nabi Nagar STPP	Central Sector	Bihar	ER	U-1	660	29-03-2019
4	NTPC	Solapur STPP	Central Sector	Maha.	WR	U-2	660	29-03-2019
5	NTPC	Gadarwara TPP	Central Sector	MP	WR	U-1	800	29-03-2019
6	NTPC	Khargone TPP	Central Sector	MP	WR	U-1	660	30-08-2019
7	NTPC	Tanda TPP	Central Sector	UP	NR	U-5	660	14-09-2019
8	GSECL	Wanakbori TPS Extn.	State Sector	Gujarat	WR	U-8	800	14-06-2019

Projects commissioned after March 2018

S.No.	Developer	Project Name	Sector	State	Region	Unit No	Cap. (MW)	Dt of Comm.
9	MPPGCL	Shri Singhaji TPP St-II	State Sector	MP	WR	U-3	660	18-11-2018
10	MPPGCL	Shri Singhaji TPP St-II	State Sector	MP	WR	U-4	660	27-03-2019
11	OPGCL	Ib valley TPP	State Sector	Odisha	ER	U-3	660	20-04-2019
12	OPGCL	Ib valley TPP	State Sector	Odisha	ER	U-4	660	11-05-2019
13	RRVUNL	Chhabra TPP Extn.	State Sector	Rajasthan	NR	U-6	660	29-03-2019
14	TSGENCO	Kothagudem TPS St-VII	State Sector	Telangana	SR	U-1	800	26-12-2018
15	RKM Powergen	Uchpinda TPP	Private Sector	Chhattisgarh	WR	U-4	360	20-03-2019
16	Essar Power MP Ltd.	Mahan TPP	Private Sector	MP	WR	U-2	600	07-10-2018
			TOTAL				9800	

Units under construction

Total Capacity of under construction units = 60896 MW

Total number of units = 112 nos.

Issues & Challenges

Issues

1. **Water consumption** for New Thermal Power Plants shall have to meet 2.5 m^3/MWh :
   "Specific water consumption shall not exceed 3.0 m^3/MWh for new plants installed after 1st January 2017 and these plants shall also achieve zero water discharge consumption"
   Water consumption norms shall not be applicable to the Thermal Power Plants using Sea water.

2. **Chimney Height:** Thermal Power Plants with FGD
   100 MW and above, $H = 6.902\ (Q \times 0.277)^{0.555}$ or 100 m which ever is more
   Less than 100 MW, $H = 6.902\ (Q \times 0.277)^{0.555}$ or 30 m which ever is more
   Q = Emission rate of SO_2 in kg/hr
   H = Physical stack height in meters

3. Method of measurement of SO2, NOx and Particulate Matter
   All monitored values for SO2, NOx and Particulate Matter shall be corrected to 6% Oxygen, on dry basis

Notification dated 28.6.2018 has been issued by MoEF&CC in this regard.

4. Clarification pending: Norms to be maintained on continuous/ hourly/daily/monthly average basis.

NOx norms

- MoEF&CC's vide Notification dated 07.12.2015 notified norms for NOx emission as:

TPPs (units) installed before 31.12.2003	TPPs (units) installed after 01.01.2004 and up to 31.12.2016	TPPs (units) to be installed from 1.1.2017
600 mg/Nm^3	300 mg/Nm^3	100 mg/Nm^3

- By combustion modification difficult to achieved 300 mg/Nm^3.
- MoEF&CC has agreed to consider for revising norms of 300 mg/Nm3 to 450 mg/Nm3.

- **Pilot Studies on SCR & SNCR technology:**
- Report has been submitted to MOEF & CC
- **TPPs installed after 01.01.2017**: NOx norms revision in under consideration of MoEF&CC from 100mg/Nm3 to 450mg/Nm3.

Reasons for Delay

1. Delay in award of tenders as there is lack of technical and operational expertise in the market and with power utilities regarding technology of FGDs that is relatively new.
2. Limited capability of FGD vendors to supply FGDs. E.g. BHEL has a capability to install FGDs in 44 GW of thermal capacity. GE has capability to install FGDs in 11.5 GW of thermal capacity.
3. Almost one year is required in the pre-construction phase of FGD. Further, 30 months period is required for construction of FGD after the LOA. Hence, total of 3.5 years.
4. Several clarifications in norms were cleared by MoEF&CC only by 28th June 2018
5. Thermal power plants located in NCR were given only 1.5 year for compliance.
6. Challenge of construction during monsoon season.

Challenges in Execution

- Huge capacity of more than 235 GW
- FGD market is developing in India
- Limited Vendors are available
- About 30% FGD items to be imported.
- Increased manufacturing time due to overbooking of suppliers
- Cost is increasing
- Funding issue specially in private plant
- Synchronizing the Erection schedule with annual overhauling to avoid DC loss

SL. No	List of Imported items
1.	Slurry Recirculation Pumps
2.	Oxidation Blowers& accessoried
3.	Limestone Grinding System (Wet Ball Mill)
4.	Gypsum Dewatering System (Vacuum Belt filter)
5.	Slurry Pumps & accessories
6.	Agitators for Tanks & Drain plts
7.	Spray Nozzles
8.	Spray Pipes

How Many FGD vendors are available in India

- **At present, there are six vendors qualified for FGD Packages for NTPC Projects:**
  - **BHARAT HEAVY ELECTRICALS LTD**
  - **Larsen & Toubro Limited**
  - **ISGEC Heavy Engineering Limited**
  - **Mitsubishi Hitachi Power Systems India Pvt. Ltd.**
  - **GE POWER INDIA LIMITED**
  - **THERMAX LIMITED**
  - **TATA**

Why implementation time line cannot be 10 years.

- **It could have been better done in a phased manner, starting from power plants in critically polluted areas to power plant clusters and then stand alone power plants; considering**
  - **the financial resources involved**
  - **time required for retrofitting and shut down required**
  - **limitations for indigenous technology and vendors etc.**
- **However, there was an apprehension that increasing timeline for implementation could push the starting point for implementation forward.**

Impact of SO2 from Chimney

NTPC A Maharatna Company

- Sulfur dioxide (SO_2) is a colourless gas with a sharp, irritating odour. It is produced by burning fossil fuels that contain sulfur.
- SO2 release from chimney goes around 5 km vicinity area. It impact around 2-3 micro gm/Nm3 for per 100 mg/Nm3.
- SO2 release from Chimney at higher temperature when it comes at lower temperature then it converts in secondary particle sulphate as PM2.5, which depends upon mist available and solar ambient conditions.
- SO2 and So4 does not accumulative properties as it dissolves in water or in case of rain.

Environmental effects

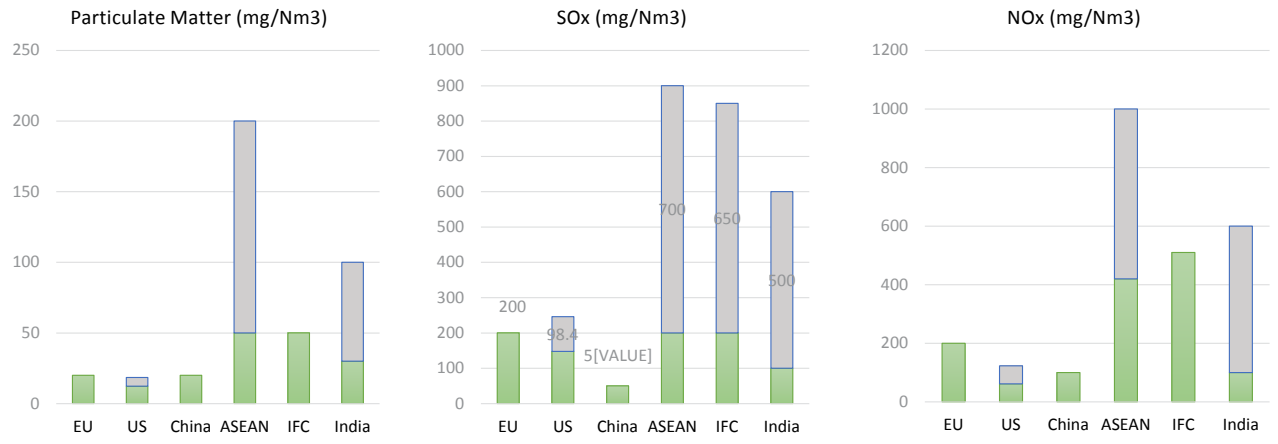
When sulfur dioxide combines with water and air, it forms sulfuric acid, which is the main component of acid rain. Acid rain can: cause deforestation,acidify waterways to the detriment of aquatic life,corrode building materials and paints.

Health effects

Sulfur dioxide affects the respiratory system, particularly lung function, and can irritate the eyes.

Sulfur dioxide irritates the respiratory tract and increases the risk of tract infections. It causes coughing, mucus secretion and aggravates conditions such as asthma and chronic bronchitis.

Global norms for thermal power plant emissions



International Finance Corporation (**IFC**)-World Bank

Is there any international norm guideline/ value for each parameter? What is the basis for finalising values of new norm for India?

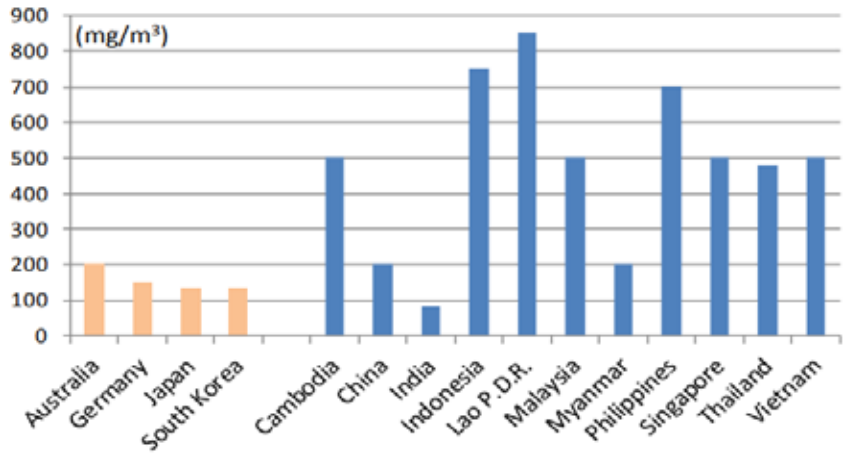
- There is no legally binding international norms for emission levels of PM, SO_2 and NOx.
- However, World Health Organisation publishes Air Quality Guidelines based on **a review of the accumulated scientific evidence** world wide on impacts of air pollutants on human health.
- **These guidelines are applicable across all WHO regions and inform policy-makers considering various options for air quality management in different parts of the world about the targets for air quality.**
- Various countries adopt their Ambient Air Quality Standards based on these guideline values and several other factors, such as **Selection of pollutants and pollutant characteristics to regulate, Adverse health effects, Acceptability of risk, Vulnerable population groups, Uncertainty, Feasibility and cost considerations**

NCR – Detailed Status

Sector	Developer	Name of Project	FGD Status	Sum of Unit Capacity	Count of Unit No
Central Sector	NTPC	Dadri (NCTPP)	Bid Awarded	1820	6
		Indira Gandhi STPP	Bid Awarded	1500	3
Private Sector	China Light Power	Mahatma Gandhi TPS	FGD operational. Meeting new norms	1320	2
	L&T Power Ltd	Nabha TPP (Rajpura TPP)	NIT issued	1400	2
	Talwandi Sabo Power Ltd	Talwandi Sabo TPS	NIT issued	1980	3
State Sector	HPGC	Panipat TPS	Bid opened	710	3
		Rajiv Gandhi TPS	Bid opened	1200	2
		Yamuna Nagar TPS	NIT issued	600	2
	PSEB	GH TPS (Leh.Moh.)	NIT issued	920	4
		GGS TPS (Ropar)	NIT issued	840	4
	UPRVUNL	Harduaganj TPS	NIT isued	500	2
Grand Total				12790	33

Norms in India vs other countries

SOx



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The Forum's mission is development of sustainable and competitive energy sector, promoting a favourable regulatory framework, establishing standards for reliable and safety, ensuring an equitable deal for consumers, producers and the utilities, encouraging efficient and eco-friendly development and use of energy and developing new and better technologies to meet the growing energy needs of the society. Its membership includes all the key players of the sector including NTPC, NHPC, Power Grid Corporation, Power Finance Corporation, Reliance Energy, ONGC, Indian Oil Corporation, Neyveli Lignite, Coal India, Tata Power, Reliance Energy, Unocal, Alstom and over 70 highly respected energy experts. It works closely with prestigious chambers and trade associates including Bombay Chamber, Bengal Chamber, Bangalore Chamber, Madras Chamber, Maratha Chambers (Pune), PHD Chamber, Observer Research Foundation, IREDA, INWEA, India Coal Forum, FIPI and National Solar Federation of India.

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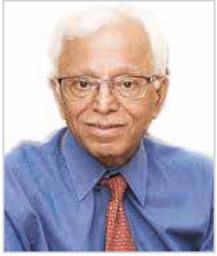

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Embracing the Future Trends...in Power

Where Progress is Performance...

- TECHNO, a synonym of Performance has been in the forefront of National Power Development Programme in the Generation, Transmission and Distribution Sector since 1980.
- TECHNO continues to implement inventive technologies as per industry trends to cut across competition and participate in less-crowded but highly valuable segments. TECHNO is the first mover in several markets of the power sector.
- When POWERGRID proposed the use of the STATCOM technology, owing to its better reactive power controllability, TECHNO partnered with the Chinese manufacturer, Rongxin to Install STATCOM at Six Substations.
- TECHNO has entered into FGD business (FGD is an environmental SOX solution pursuant to the 2015 Government of India mandate to limit sulphur emission levels). FGD is an electromechanical solution and Techno can offer a best possible single window solution to customer. On date Techno is executing wet FGD system for 500 Mw Bokaro "A" Thermal Power Station of DVC.
- Techno carries on its clean energy development program as an independent renewable energy producer with 129.9 MW wind energy capacity.
- Towards growing Government preference for the private sector's role in the power transmission and distribution segment, TECHNO has set up and owns a 102KM, 400KV Transmission Link with 2 Nos. 400/220/132KV Substations of 2400MVA capacity in Haryana and 1 No. 400/220 KV GIS S/S of 1000MVA Capacity in Nagaland in PPP Model (under construction).
- TECHNO is focusing on opportunities in overseas market in Africa and SAARC countries. It has successfully completed a project valued at $18 million in Uganda and are executing a 500 kV substation project valued at $26 million in Afghanistan.
- In Generation sector, Techno has executed small capacity Captive Power Plants as well as BoP for Ultra Mega Thermal Power Plants both for Electrical & Mechanical Auxiliary Systems.
- TECHNO also executed prestigious coal based fluidized heater project for Mitsubishi Chemicals.
- In Transmission, Techno is well acknowledged Country leader having already executed 7 Nos. 765 KV and more than 55 Nos. of 400 KV Substations, both AIS and GIS Types on EPC basis.
- In Distribution Sector, Techno has again emerged as one of the best Performer in execution of very large APDRP / RGGVV / IPDS / DDUGJY Projects including extension of networks, Grid Modernisation etc under Schemes of Government of India across the Country.

Awards

- Techno's Performance has been recognised by the Government of India and other Giants in Power Sector. To mention a few,
- Award from PGCIL in 2018 for being the "Best Player in 765KV AIS Substation Construction in India".
- IEI Industry Excellence Award – 2016 for demonstrating highest order of Business Excellence from IEI.
- Conferred with Best Performance & Safety Award in 2016, 2015, 2014 and 2013 from PGCIL.
- Received Safety Award from NTPC in 2018 for 'Best HSE Performance' at Kudgi site

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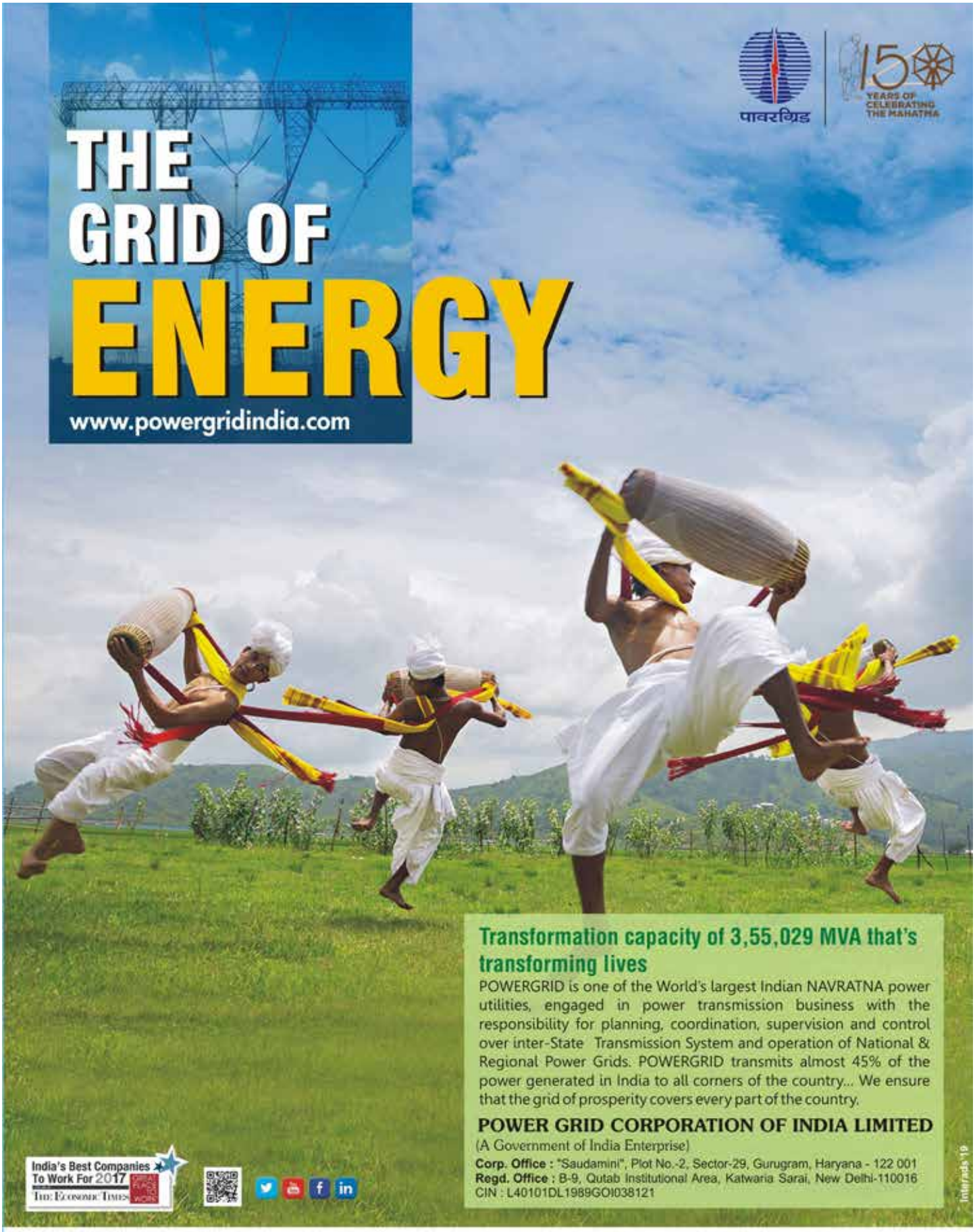

• Transmission Lines >151,507 ckm • Sub-station 239 Nos. • System Availability >99% • All India Inter-Regional capacity more than 90,650 MW
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